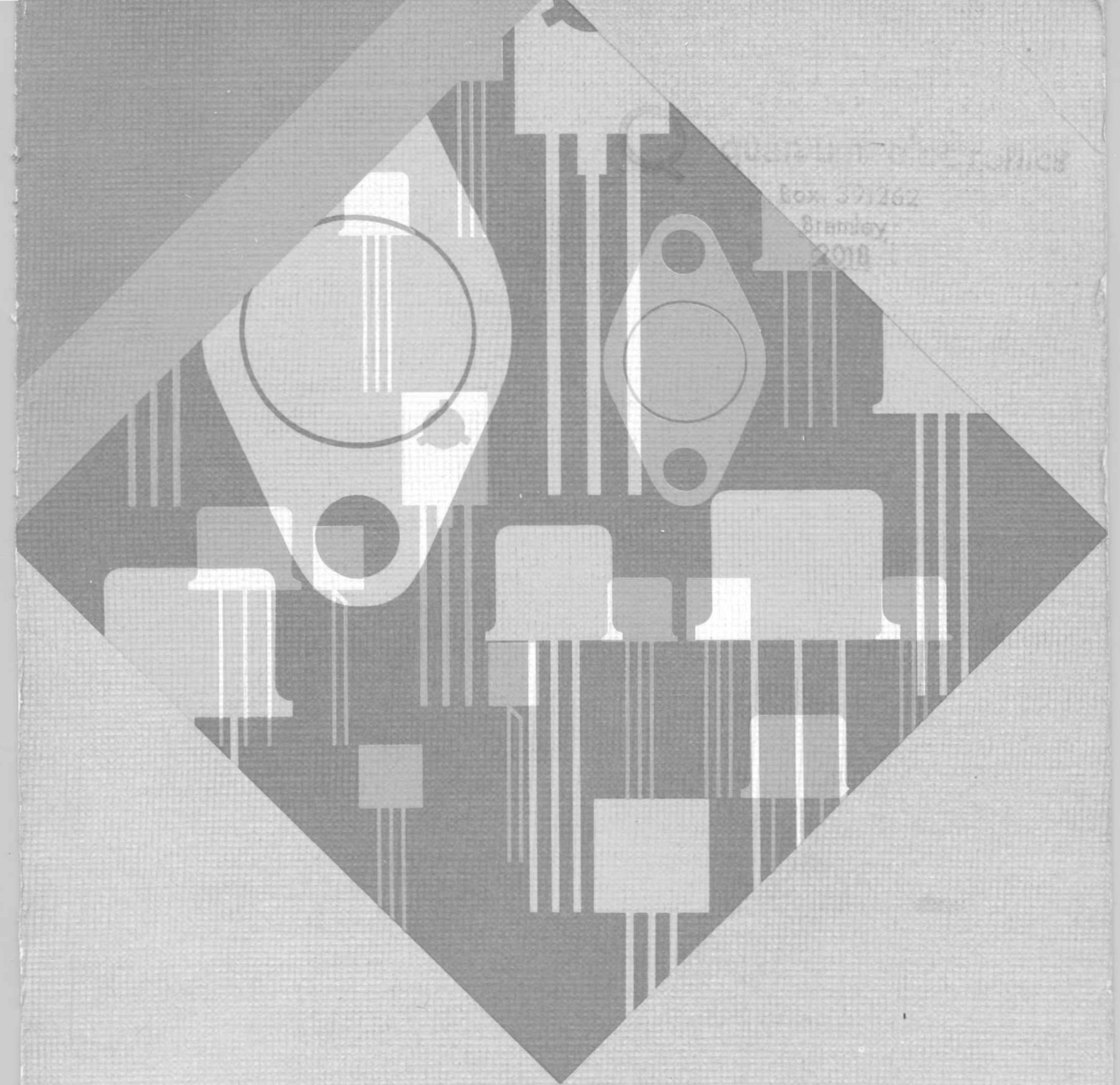



# Transistors 1976/77

6240-08-1E

semiconductors ITT

General Information



NPN Silicon Transistors

NPN Silicon
High Frequency Transistors

PNP Silicon Transistors

PNP Silicon
High Frequency Transistors

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# Transistors

Total Product Range
for Consumer Applications
and Professional Electronics

Manual 1976/77

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in plastic case ≈ TO-92

BC 173, BC 239, BC 413, BC 414, BC 549, BC 550

**AF general purpose transistors for switching and amplifier applications**

in metal case JEDEC TO-18

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in plastic case ≈TO-92

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in plastic case ≈ TO-92

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**Index of Symbols**

| | |
|---|---|
| $b$ | Imaginary part of $y$-parameters |
| $b_f$ | Imaginary part of forward transconductance $y_f$ |
| $b_i$ | Imaginary part of input admittance $y_i$ |
| $b_o$ | Imaginary part of output admittance $y_o$ |
| $b_r$ | Imaginary part of reverse transconductance $y_r$ |
| $B$ | Base connection |
| $B_G$ | Imaginary part of generator (source) impedance |
| $C$ | Capacitance; junction capacitance; collector connection |
| $C_i$ | Input capacitance ($b_i/2\pi f$) |
| $C_o$ | Output capacitance ($b_o/2\pi f$) |
| $C_{CB0}$ | Collector base capacitance (open emitter) |
| $C_{EB0}$ | Emitter base capacitance (open collector) |
| $C_r$ | Feedback capacitance ($b_r/2\pi f$) |
| $E$ | Emitter connection |
| $f$ | Frequency |
| $f_T$ | Gain bandwidth product |
| $F$ | Noise figure |
| $F_c$ | Noise figure in mixer stages |
| $g$ | Real part of $y$-parameters |
| $g_f$ | Real part of forward transconductance $y_f$ |
| $g_i$ | Real part of input admittance $y_i$ |
| $g_o$ | Real part of output admittance $y_o$ |
| $g_r$ | Real part of reverse transconductance $y_r$ |
| $g_s$ | Generator conductance |
| $G_C$ | Current gain |
| $G_P$ | Power gain |
| $G_{P\,av}$ | Available power gain |
| $G_{P\,max}$ | Max. available power gain |
| $G_V$ | Voltage gain |
| $h$ | Parameters of $h$- (hybrid) matrix |
| $h_f$ | Small signal current gain |
| $h_i$ | Input impedance |
| $h_o$ | Output admittance |
| $h_r$ | Reverse voltage transfer ratio |
| $h_{FE}$ | DC current gain, common emitter |
| $I_B$ | Base current |
| $I_{BM}$ | Peak base current |
| $I_{B1}$ | Turn-on current |

| | |
|---|---|
| $I_{B2}$ | Turn-off current |
| $I_C$ | Collector current |
| $I_{CAV}$ | Average collector current |
| $I_{CBO}$ | Collector base cutoff current (open emitter) |
| $I_{CEO}$ | Collector emitter cutoff current (open base) |
| $I_{CER}$ | Collector emitter cutoff current (specified resistance between base and emitter) |
| $I_{CES}$ | Collector emitter cutoff current (base short-circuited to emitter) |
| $I_{CEV}$ | Collector emitter cutoff current (specified voltage between base and emitter) |
| $I_{CM}$ | Peak collector current |
| $I_E$ | Emitter current |
| $I_{EBO}$ | Emitter base cutoff current (open collector) |
| $K_V$ | Thermal resistance correction factor |
| $P_{tot}$ | Power dissipation |
| $P_D$ | Continuous power dissipation |
| $P_I$ | Pulse power dissipation |
| $r_{b'} \cdot C_c$ | Collector base time constant |
| $r_{thA}$ | Pulse thermal resistance junction to ambient air |
| $r_{thC}$ | Pulse thermal resistance junction to case |
| $R$ | Resistance; resistor |
| $R_{BE}$ | Resistance between base and emitter |
| $R_G$ | Generator impedance; source impedance |
| $R_{G\,opt}$ | Optimum (matched) generator resistance |
| $R_L$ | Load resistance |
| $R_{L\,opt}$ | Optimum (matched) load resistance |
| $R_S$ | Series resistance |
| $R_{th}$ | Thermal resistance |
| $R_{thA}$ | Thermal resistance junction to ambient air |
| $R_{thC}$ | Thermal resistance junction to case resp. mounting base |
| $R_{thC/S}$ | Thermal resistance case or mounting base to heat sink |
| $R_{thS}$ | Thermal resistance heat sink to ambient air |
| $t$ | Time |
| $t_d$ | Delay time |
| $t_f$ | Fall time |
| $t_{off}$ | Turn-off time $(t_s + t_f)$ |
| $t_{on}$ | Turn-on time $(t_d + t_r)$ |
| $t_p$ | Pulse duration |
| $t_r$ | Rise time |

| | |
|---|---|
| $t_s$ | Storage time |
| $t_{total}$ | Total switching time ($t_{on} + t_{off}$) |
| $T$ | Temperature; duration of one period |
| $T_{amb}$ | Ambient temperature |
| $T_j$ | Junction temperature |
| $T_C$ | Case temperature |
| $T_S$ | Storage temperature |
| $V$ | Voltage |
| $V_{BB}$ | Base supply voltage |
| $V_{BE}$ | Base emitter voltage |
| $V_{BE\,sat}$ | Base emitter saturation voltage |
| $V_{(BR)CBO}$ | Collector base breakdown voltage (open emitter) |
| $V_{(BR)CEO}$ | Collector emitter breakdown voltage (open base) |
| $V_{(BR)CES}$ | Collector emitter breakdown voltage (emitter short-circuited to base) |
| $V_{(BR)EBO}$ | Emitter base breakdown voltage (open collector) |
| $V_{CB}$ | Collector base voltage |
| $V_{CBO}$ | Collector base voltage (open emitter) |
| $V_{CC}$ | Collector supply voltage |
| $V_{CE}$ | Collector emitter voltage |
| $V_{CEO}$ | Collector emitter voltage (open base) |
| $V_{CER}$ | Collector emitter voltage (specified resistance between base and emitter) |
| $V_{CES}$ | Collector emitter voltage (emitter short-circuited to base) |
| $V_{CE\,sat}$ | Collector emitter saturation voltage |
| $V_{CEV}$ | Collector emitter voltage (specified voltage between base and emitter) |
| $V_{EBO}$ | Emitter base voltage (open collector) |
| $V_{EE}$ | Emitter supply voltage |
| $y$ | Parameters of y- (admittance) matrix |
| $y_f$ | Forward transconductance |
| $y_i$ | Input admittance |
| $y_o$ | Output admittance |
| $y_r$ | Reverse transconductance |
| $y_s$ | Generator admittance |
| $Z_1$ | Input impedance |
| $Z_2$ | Output impedance |
| $\varphi$ | Phase angle of $y$-parameters |
| $\tau_s$ | Storage time constant |
| $\nu$ | Duty cycle ($t_p/T$) |

**Characteristics and Maximum Ratings**

The electrical performance of a semiconductor device is usually expressed in terms of its characteristics and maximum ratings.

**Characteristics** are those which can be measured by use of suitable measuring instruments and circuits, and provide information on the performance of the device under specified operating conditions (at a given bias, for example). Depending on requirements, they are quoted either as typical values or guaranteed values.

Typical values are expressed as figures or as one or more curves, and are subject to spreads.

Guaranteed values are preceded either by the symbol > (greater than) or < (less than); sometimes the guaranteed spread limits are indicated by the numbers with three dots between them. Occasionally a typical curve is accompanied by another curve, this being a 95 %, or, in a few cases, a maximum spread limit curve.

**Maximum Ratings** give the values which cannot be exceeded without risk of damage to the device. Changes in supply voltage and in the tolerances of other components in the circuit must also be taken into consideration. No single maximum rating should ever be exceeded, even when the device is operated well within the other maximum ratings. The inclusion of the word "admissible" in a title means that the associated curve defines the maximum ratings.

An exception to this rule are data on collector current. The collector current, quoted as one of the critical transistor values, is a maximum value recommended by the manufacturer which should be noted in connection with the other characteristics valid for this collector current (e. g. collector and saturation voltages, current gain etc.) when selecting a transistor. In certain cases, the quoted collector current may be exceeded without the transistor being destroyed. The absolute limit for the collector current is determined by the maximum admissible power dissipation of the transistor.

**Assembly and Soldering Instructions**

To prevent transistors from being damaged during mounting, observe the following points:

The leads must under no circumstances be bent immediately adjacent to the glass seals. Material stresses set up in this way may produce cracks in the glass, often only after a certain delay, and may lead to the destruction of the component. The point at which leads are bent should not be less than 2 mm away from the glass seal.

All semiconductor devices are extremely sensitive to their maximum admissible junction temperature being exceeded. When planning the layout of the equipment, the distance between heat sources and semiconductor elements should be sufficiently large.

Semiconductor elements may be mounted in any desired position.

From the experience gained in soldering semiconductor elements the following rules have emerged:

When bit-soldering at copper bit temperatures from 230 . . . 250 °C, the soldering time should not exceed 5 s. The distance between soldered joint and glass seal should be at least 5 mm. For leads shorter than 5 mm additional heat dissipation must be provided, for example, by means of a cooling clip.

When dip-soldering printed circuits, the temperature of the soldering bath should not exceed 240 °C. If the distance between soldered joint and mounting surface or glass seal is at least 5 mm the maximum dipping time is 10 s. For leads of 3 mm length, the maximum dipping time is restricted to 5 s.

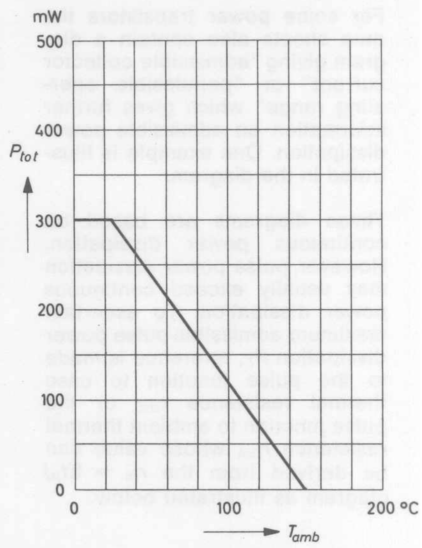
For transistors in plastic cases the maximum soldering time ist 8 s, at soldering temperatures between 230 and 260 °C. Here, the distance between soldered joint and case should be at least 4 mm. During soldering, the leads should not be subjected to mechanical stress.

## Admissible Power Dissipation

The indicated maximum admissible junction temperature must not be exceeded because this could damage or cause the destruction of the transistor crystal. Since the user cannot measure this temperature, data sheets also reveal the maximum admissible power dissipation $P_{tot}$ usually in the form of a derating curve (see diagram).

If power dissipation is kept within these limits the maximum junction temperature will not be exceeded. This can easily be checked by using the equation

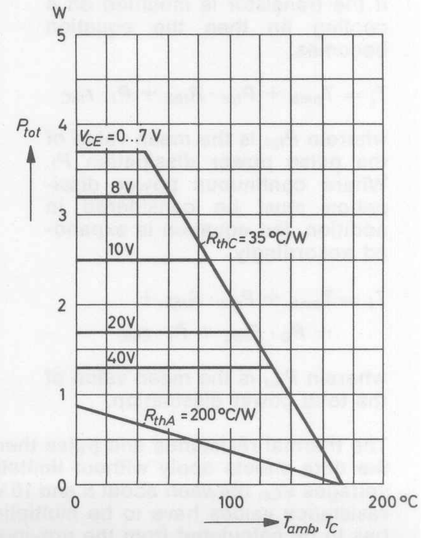
$$T_j = T_{amb} + P_{tot} \cdot R_{th}$$



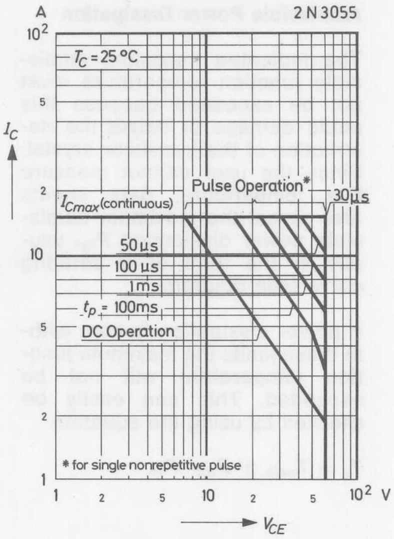

For the thermal resistance $R_{th}$ the junction to ambient thermal resistance $R_{thA}$ is usually substituted in the case of small transistors (in the TO-18, TO-39 or TO-92 package). In the case of power transistors (in the TO-3, SOT-9 or similar packages) which are usually mounted on a cooling fin or heat sink for the purpose of heat dissipation, the sum of the junction to case thermal resistance $R_{thC}$ plus the heat sink to ambient thermal resistance $R_{thS}$ plus – for more accurate calculations – the mounting surface to heat sink thermal resistance is substituted for the thermal resistance in this equation. In order to keep the mounting surface to heat sink thermal resistance low, a heat conducting compound (silicone grease) is to be applied to the mounting surface before the transistor is screwed on. If a mica insulation is used, the thermal resistance of the mica washer must be added which amounts to about 0.5 °C/W.

Directions for determining the thermal resistance $R_{thS}$ for cooling fins can be found on page 20.

Since the distribution of heat in the transistor crystal is not uniform and depends on voltage and current, some transistors are accompanied by derating curves showing $P_{tot}$ as a function of $T_C$ and $T_{amb}$ with the collector voltage $V_{CE}$ as parameter (see diagram).



For some power transistors the data sheets also contain a diagram giving "admissible collector current" or "permissible operating range" which gives further information on admissible power dissipation. One example is illustrated in the diagram.



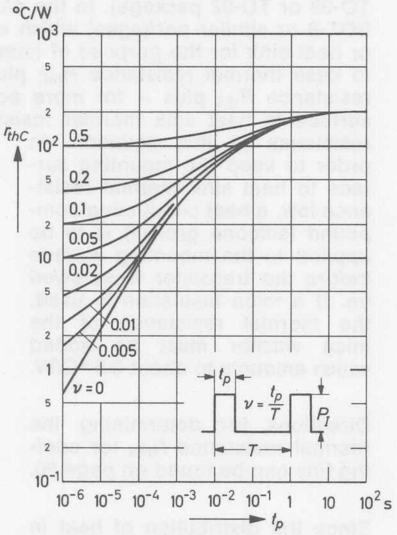

These diagrams are based on continuous power dissipation. However, pulse power dissipation may usually exceed continuous power dissipation. To ascertain maximum admissible pulse power dissipation $P_I$, reference is made to the pulse junction to case thermal resistance $r_{thC}$ or the pulse junction to ambient thermal resistance $r_{thA}$ whose value can be derived from the $r_{th} = f(t_p)$ diagram as illustrated below.

Use the equation

$$T_j = T_{amb} + P_I \cdot r_{thA}$$

or, if the continuous power dissipation $P_D$ is to be taken into consideration:

$$T_j = T_{amb} + P_D \cdot R_{thA} + P_I \cdot r_{thA}$$




If the transistor is mounted on a cooling fin then the equation becomes:

$$T_j = T_{amb} + P_{tot} \cdot R_{thS} + P_I \cdot r_{thC}$$

wherein $P_{tot}$ is the mean value of the pulse power dissipation $P_I$. Where continuous power dissipation must be considered in addition, the equation is expanded accordingly:

$$T_j = T_{amb} + P_{tot} \cdot R_{thS} + P_D \cdot R_{thC} + P_I \cdot r_{thC}$$

wherein $P_{tot}$ is the mean value of the total power dissipation.

The thermal resistance and pulse thermal resistance values derived from the data sheets apply without limitation only to small collector emitter voltages $V_{CE}$, between about 5 and 10 V. For higher voltages these thermal resistance values have to be multiplied by a correction factor $K_V$ which has to be calculated from the previously mentioned derating curves. The

admissible power dissipation $P_{tot\,max}$, applicable to low collector voltages, must be divided by the admissible power dissipation $P_{tot\,V}$ for the higher collector voltage $V$:

$$K_V = \frac{P_{tot\,max}}{P_{tot\,V}}$$

The complete equation for $T_j$ then reads:

$$T_j = T_{amb} + P_{tot} \cdot R_{thS} + P_D \cdot K_V \cdot R_{thC} + P_I \cdot K_V \cdot r_{thC}$$

### Heat Removal from Transistors

The operation of any semiconductor device involves the dissipation of power with a consequent rise in junction temperature. Because the maximum admissible junction temperature must not be exceeded, careful circuit design with due regard not only to the electrical, but also the thermal performance of a semiconductor circuit, is essential.

If the dissipated power is low, then sufficient heat is radiated from the surface of the case; if the dissipation is high, however, additional steps may have to be taken to promote this process by reducing the thermal resistance between the junction and the ambient air. This can be achieved either by pushing a star- or flag-shaped heat dissipator over the case, or by bolting the semiconductor device to a heat sink.

$P$, the power to be dissipated, $T_j$ the junction temperature, and $T_{amb}$, the ambient temperature are related by the formula

$$P = \frac{T_j - T_{amb}}{R_{thA}} = \frac{T_j - T_{amb}}{R_{thC} + R_{thS}},$$

where $R_{thA}$ is the total thermal resistance between junction and ambient air. The total thermal resistance in turn comprises an internal thermal resistance $R_{thC}$ between the junction and the mounting base, and an outer thermal resistance $R_{thS}$ between the case and the surrounding air (or any other cooling medium). It should be noted that only the outer thermal resistance is affected by the design of the heat sink. To determine the size of the heat sink required to meet given operating conditions, proceed as follows: First calculate the outer thermal resistance by use of the formula

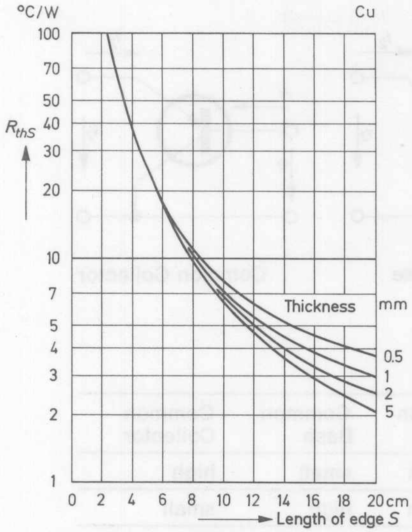
$$R_{thS} < \frac{T_j - T_{amb}}{P} - R_{thC}$$

and then, by use of the diagrams shown on next page, determine the size of the heat sink which provides the calculated $R_{thS}$-value. To determine the maximum admissible device dissipation and ambient temperature limit for a given heat sink, proceed in the reverse order to that described above.

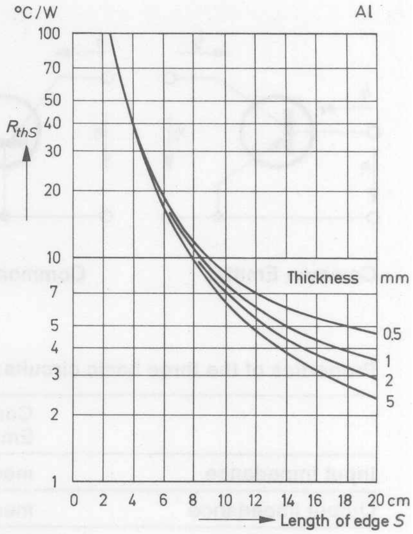
The calculations are based on the following assumptions: Use of a squareshaped heat sink without any finish, mounted in a vertical position; semiconductor device located in the centre of the sink; heat sink operated in still air and not subjected to any additional heat radiation. The calculated area should be increased by a fator of 1.3 if the sink is mounted horizontally, and can be reduced by a factor of approximately 0.7 if a black finish is used.

The curves on the following page give the thermal to ambient resistance of square vertical heat sinks as a function of side length. It is assumed that the heat is applied at the centre of the square.

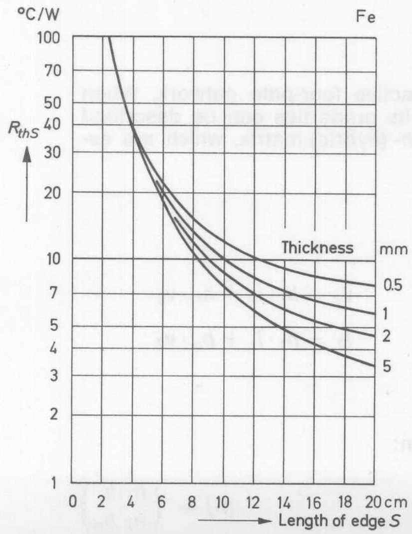
**Copper Cooling Fin**




**Aluminium Cooling Fin**

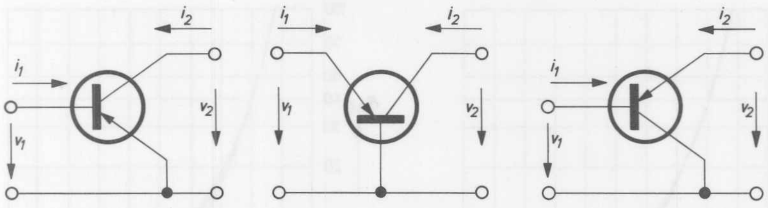



**Steel Cooling Fin**



## Basic Circuits

There are three basic transistor circuits. They are called according to that electrode (emitter, base, collector) which is common to both input and output circuit.



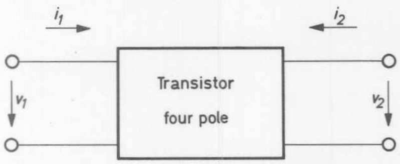

Common Emitter    Common Base    Common Collector

Properties of the three basic circuits:

| | Common Emitter | Common Base | Common Collector |
|---|---|---|---|
| Input impedance | medium | small | high |
| Output impedance | medium | high | small |
| Current gain | high | less than 1 | high |
| Upper frequency limit | low | high | low |

## Four-Pole Symbols of *h*-Matrix

A transistor can be considered as an active four-pole network. When driven with small low-frequency signals its properties can be described by the four characteristic values of the *h*- (hybrid) matrix, which are assumed to be real.




$$v_1 = h_i \cdot i_1 + h_r \cdot v_2$$

$$i_2 = h_f \cdot i_1 + h_o \cdot v_2$$

If expressed this in matrix form we obtain:

$$\begin{pmatrix} v_1 \\ i_2 \end{pmatrix} = (h) \begin{pmatrix} i_1 \\ v_2 \end{pmatrix} \qquad (h) = \begin{pmatrix} h_i & h_r \\ h_f & h_o \end{pmatrix}$$

**Explanation of *h*-Parameters**

Input impedance (shorted output) ($v_2 = 0$): $h_i = \frac{v_1}{i_1}$

Reverse voltage transfer ratio (open input) ($i_1 = 0$): $h_r = \frac{v_1}{v_2}$

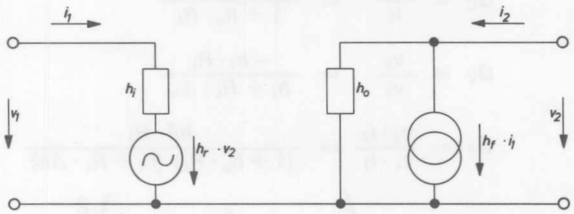
Small signal current gain (shorted output) ($v_2 = 0$): $h_f = \frac{i_2}{i_1}$

Output admittance (open input) ($i_1 = 0$): $h_o = \frac{i_2}{v_2}$

A frequently used abbreviation is the determinant:

$\Delta h = h_i \cdot h_o - h_r \cdot h_f$

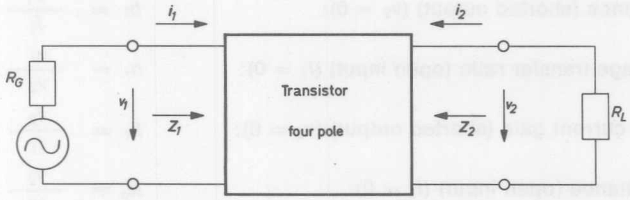
For all three basic circuit configurations the circuit illustrated below represents the equivalent four-pole circuit using *h*-parameters.




In the transistor data sheets the *h*-parameters are usually quoted for the common emitter configuration and for a given operating point (bias). The latter is determined by the collector voltage, the emitter or collector current and by the ambient temperature. For different operating points, correction factors are needed which can be gathered from the relevant curves. For common base or common collector transistor stage calculations, the appropriate *h*-parameters are ascertained from those of the common emitter configuration by using the following conversion formulas.

| | Common Emitter | Common Base | Common Collector |
|---|---|---|---|
| Input impedance | $h_{ie}$ | $h_{ib} = \frac{h_{ie}}{1 + h_{fe}}$ | $h_{ic} = h_{ie}$ |
| Reverse voltage transfer ratio | $h_{re}$ | $h_{rb} = \frac{h_{ie} \cdot h_{oe}}{1 + h_{fe}} - h_{re}$ | $h_{rc} = 1 - h_{re}$ |
| Small signal current gain | $h_{fe}$ | $h_{fb} = -\frac{h_{fe}}{1 + h_{fe}}$ | $-h_{fc} = 1 + h_{fe}$ |
| Output admittance | $h_{oe}$ | $h_{ob} = \frac{h_{oe}}{1 + h_{fe}}$ | $h_{oc} = h_{oe}$ |

## Calculation of a Transistor Stage




Input impedance $$Z_1 = \frac{v_1}{i_1} = \frac{h_i + R_L \cdot \Delta h}{1 + h_o \cdot R_L}$$

Output impedance $$Z_2 = \frac{v_2}{i_2} = \frac{h_i + R_G}{\Delta h + h_o \cdot R_G}$$

Current gain $$G_C = \frac{i_2}{i_1} = \frac{h_f}{1 + h_o \cdot R_L}$$

Voltage gain $$G_V = \frac{v_2}{v_1} = \frac{-h_f \cdot R_L}{h_i + R_L \cdot \Delta_h}$$

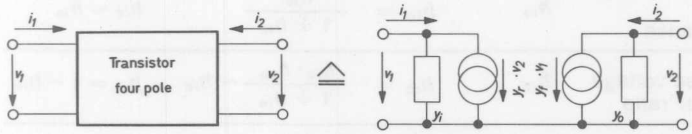
Power gain $$G_P = \frac{v_2 \cdot i_2}{v_1 \cdot i_1} = \frac{h_f^2 \cdot R_L}{(1 + h_o \cdot R_L)\ (h_i + R_L \cdot \Delta h)}$$

Max. available power gain input and output matched with $R_{G\,opt}$ resp. $R_{L\,opt}$ $$G_{p\,max} = \left( \frac{h_f}{\sqrt{\Delta h} + \sqrt{h_i \cdot h_o}} \right)^2$$

$$R_{G\,opt} = \sqrt{\frac{h_i\,\Delta h}{h_o}} \qquad R_{L\,opt} = \sqrt{\frac{h_i}{h_o\,\Delta h}}$$

### Four-Pole Symbols of *y*-Matrix

Whereas the network behaviour of low-frequency transistors could be described by using the *h*- (hybrid) matrix, the *y* (admittance) matrix is usually employed for high frequency transistors.




$$i_1 = y_i \cdot v_1 + y_r \cdot v_2$$
$$i_2 = y_f \cdot v_1 + y_o \cdot v_2$$

In matrix form we obtain:

$$\begin{pmatrix} i_2 \\ i_1 \end{pmatrix} = (y) \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} \qquad (y) = \begin{pmatrix} y_i & y_r \\ y_f & y_o \end{pmatrix}$$

The $y$-parameters are complex values which can be expressed as

$$y_{ik} = g_{ik} + jb_{ik} \quad \text{with} \quad b_{ik} = \omega C_{ik} \quad \text{or with} \quad b_{ik} = -\frac{1}{\omega L_{ik}}$$

Often, the following notation is expedient:
$y_{ik} = |\,y_{ik}\,|\, exp\; j\varphi_{ik}$

By adding the suffix $e$, $b$ or $c$ it is possible to indicate to which of the three basic circuit configurations the parameters are valid.

**Explanation of $y$-Parameters**

Input admittance (shorted output) $(v_2 = 0)$ $\quad y_i = \frac{i_1}{v_1}$

Reverse transconductance (shorted input) $(v_1 = 0)$ $\quad y_r = \frac{i_1}{v_2}$

Forward transconductance (shorted output) $(v_2 = 0)$ $\quad y_f = \frac{i_2}{v_1}$

Output admittance (shorted input) $(v_1 = 0)$ $\quad y_o = \frac{}{v_2}$

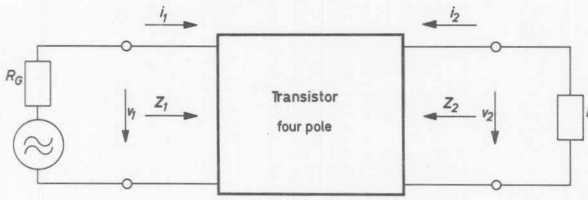
The determinant reads $\Delta y = y_i \cdot y_o - y_r \cdot y_f$

**Conversion from $y$-Parameters to $h$-Parameters**

$$h_i = \frac{1}{y_i} \qquad h_r = -\frac{y_r}{y_i} \qquad \Delta h = \frac{y_o}{y_i}$$

$$h_f = \frac{y_f}{y_i} \qquad h_o = \frac{\Delta y}{y_i}$$

**Calculation of a Transistor Stage**




Input impedance $\quad Z_1 = \frac{v_1}{i_1} = \frac{1 + y_o \cdot R_L}{y_i + \Delta y \cdot R_L}$

Output impedance $$Z_2 = \frac{v_2}{i_2} = \frac{1 + y_i \cdot R_G}{y_o + \Delta y \cdot R_G}$$

Current gain $$G_C = \frac{i_2}{i_1} = \frac{y_f}{y_i + \Delta y \cdot R_L}$$

Voltage gain $$G_V = \frac{v_2}{v_1} = \frac{-y_f \cdot R_L}{1 + y_o \cdot R_L}$$

Power gain $$G_P = \frac{v_2 \cdot i_2}{v_1 \cdot i_1} = \frac{|y_f|^2 \cdot R_L}{(1 + y_o \cdot R_L)\ (y_i + \Delta y \cdot R_L)}$$

Available power gain input matched with $R_{G\,opt}$ $$G_{P\,av} = \frac{4 \cdot y_f^2 \cdot R_G \cdot R_L}{[(y_i + \Delta y \cdot R_L) \cdot R_G + 1 + y_o \cdot R_L]^2}$$

Max. available power gain input and output matched with $R_{G\,opt}$ resp. $R_{L\,opt}$ $$G_{P\,max} = \left(\frac{y_f}{\sqrt{\Delta y} + \sqrt{y_i \cdot y_o}}\right)^2$$

Max. available power gain will be attained if input and output are matched, where:

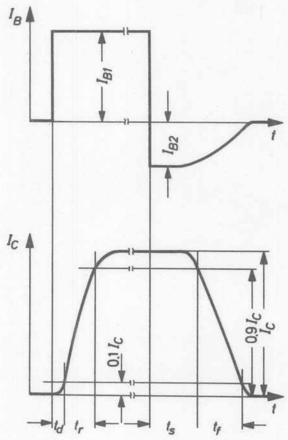
$$R_{L\,opt} = \sqrt{\frac{y_o}{y_i} \cdot \frac{1}{\Delta y}}$$

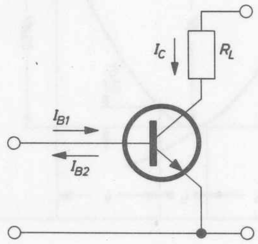
$$R_{G\,opt} = \sqrt{\frac{y_i}{y_o} \cdot \frac{1}{\Delta y}}$$

and: $$\Delta y = y_i \cdot y_o - y_r \cdot y_f$$

**Switching Times**

Definitions for the various times which make up the total switching time can be gathered from the diagram below in which the switching characteristic of a transistor in common-emitter configuration is illustrated.



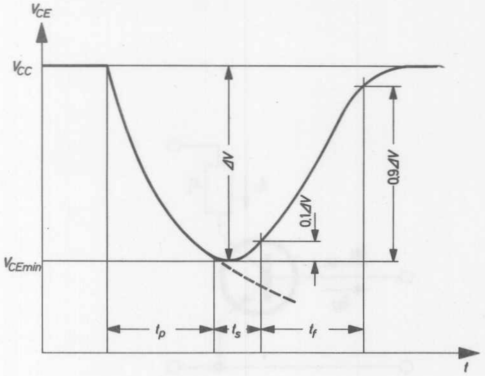




| | |
|---|---|
| $t_d$ | Delay time |
| $t_r$ | Rise time |
| $t_s$ | Storage time |
| $t_f$ | Fall time |
| $t_{on} = t_d + t_r$ | Turn-on time |
| $t_{off} = t_s + t_f$ | Turn-off time |

The duration of the switching times depends upon the transistor type and very much on the circuit arrangement.

With increasing saturation of the transistor the turn-on time decreases and the turn-off time increases. An increase of the turn-off current $I_{B2}$ shortens the turn-off time.

The switching times depend on the duration of the turn-on pulse. It is only when the duration of this pulse is a multiple of the switching times that the latter remain constant. If the pulse is shorter, especially the storage time decreases. With a pulse duration in the region of the turn-on time the transistor is no longer fully saturated. The collector voltage then exhibits a characteristic such as is qualitatively represented in the diagram below.



**DIN Standards (German)**

The information contained in this book conforms, in the main, to the following German DIN Standards.

| | |
|---|---|
| DIN 41785 Sheet 1 (10. 69) | Semiconductor devices, letter symbols on data sheets, general |
| DIN 41785 Sheet 2 (9. 71) | Semiconductor devices, letter symbols on data sheets for semiconductor devices for telecommunication |
| DIN 41791 Sheet 1 (9. 71) | Semiconductors for telecommunication, recommendations for data sheets, general |
| DIN 41791 Sheet 4 (E 10. 71) | Semiconductor devices for telecommunication, recommendations for data sheets, low power signal transistors |
| DIN 41791 Sheet 6 (10. 73) | Semiconductor devices for telecommunication, recommendations for data sheets, switching transistors |
| DIN 41854 (11. 67) | Transistors, terms and definitions |
| DIN 41855 (10. 74) | Semiconductor devices, kinds of semiconductor devices, terms and definitions |
| DIN 41868 (4. 72) | Cases 10 A 3 and 10 B 3 (JEDEC TO-92) for semiconductor devices, main dimensions |
| DIN 41870 Sheet 1 (4. 69) | Cases for semiconductor devices and integrated circuits, short designations |
| DIN 41870 Sheet 2 (7. 69) | Cases for semiconductor devices and integrated circuits, survey |
| DIN 41873 (6. 74) | Cases type 5 (JEDEC TO-39 $\approx$ TO-5) for semiconductor devices and integrated circuits |
| DIN 41876 (4. 72) | Cases 18 A 3 (JEDEC TO-18) etc. for semiconductor devices, main dimensions |

## Specifications for Quality

1. General

The quality of components is determined by statistical methods, and is quoted as a maximum permissible percentage of defectives (AQL value). AQL values are based on maximum ratings and guaranteed characteristics of electrical and mechanical parameters.

2. Defectives

A device is considered defective if any one parameter does not correspond with the value specified in the data sheet. If an item has more than one defect, then this is counted as one defect only, i. e. a batch is assessed on the number of defective items and not on the number of defects. Defects are classified according to type and extent.

Types of defects:

a) Case or lead defects
b) Electrical defects

Extent of defects:

a) Total defects are those which preclude any use of the item
b) Partial defects are those which allow restricted use of the item

3. AQL (Acceptable Quality Level) Values

The AQL values applicable to INTERMETALL semiconductor devices are summarized in the table below. The AQL values stated apply to the sum of all defectives.

| Defectives | | |
|---|---|---|
| Case and leads: | | |
| | Total defectives | 0.25 % |
| | Partial defectives | 2.50 % |
| Electrical properties: | | |
| | Total defectives | 0.25 % |
| | Partial defectives | 0.65 % |

4. Incoming Inspection

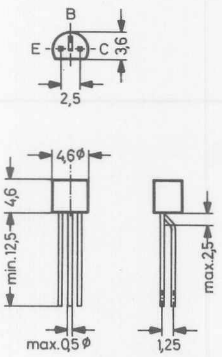
The tests carried out by the manufacturer are designed so as to obviate the need for any incoming inspection by the user. If, however, a user wishes to carry out an incoming inspection, then this should be done on a sample basis, as laid down in the internationally accepted MIL-STD 105 D specifications.

# NPN Silicon Transistors

# BC 107..., BC 171, BC 190, BC 237...

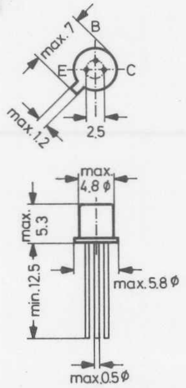
**NPN Silicon Epitaxial Planar Transistors**
for switching and amplifier applications

The transistors are subdivided into three groups A, B and C according to their current gain. Types BC 107, BC 190, BC 171, BC 174 and BC 237 are available in groups A and B, types BC 108, BC 172 and BC 238 in groups A, B and C, and types BC 109, BC 173 and BC 239 in groups B and C.
BC 109, BC 173 and BC 239 are low noise types.




**BC 171, BC 172, BC 173, BC 174**
**BC 237, BC 238, BC 239**

Plastic package ≈ JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm




**BC 107, BC 108, BC 109, BC 190**

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

| **Maximum Ratings** | | **BC 107**<br>**BC 171**<br>**BC 237** | **BC 108**<br>**BC 109**<br>**BC 172**<br>**BC 173**<br>**BC 238**<br>**BC 239** | **BC 190**<br>**BC 174** | |
|---|---|---|---|---|---|
| Collector emitter voltage | $V_{CES}$ | 50 | 30 | 70 | V |
| Collector emitter voltage | $V_{CEO}$ | 45 | 25 | 64 | V |
| Emitter base voltage | $V_{EBO}$ | 6 | 5 | 5 | V |
| Collector current | $I_C$ | 100 | 100 | 100 | mA |
| Peak collector current | $I_{CM}$ | 200 | 200 | 200 | mA |
| Base current | $I_B$ | 50 | 50 | 50 | mA |

| | | **TO-92** | **TO-18** | |
|---|---|---|---|---|
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 300 [1] | 300 | mW |
| Junction temperature | $T_j$ | 150 | 175 | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +150$ | $-55 \ldots +175$ | °C |

[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| **Characteristics** at $T_{amb} = 25\,°C$ | | **Current Gain Group** | | | |
|---|---|---|---|---|---|
| $h$-Parameters at $V_{CE} = 5$ V, $I_C = 2$ mA, $f = 1$ kHz | | **A** | **B** | **C** | |
| Small signal current gain | $h_{fe}$ | 220 (125 . . 260) | 330 (240 . . 500) | 600 (450 . . 900) | |
| Input impedance | $h_{ie}$ | 2.7 (1.6 . . 4.5) | 4.5 (3.2 . . 8.5) | 8.7 (6 . . . 15) | kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 30 (< 60) | 60 (< 110) | µmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |
| DC current gain | | | | | |
| at $V_{CE} = 5$ V, $I_C = 0.01$ mA | $h_{FE}$ | 90 | 150 | 270 | |
| at $V_{CE} = 5$ V, $I_C = 2$ mA | $h_{FE}$ | 170 | 290 | 500 | |
| at $V_{CE} = 5$ V, $I_C = 100$ mA | $h_{FE}$ | 120[1] | 200[1] | 400[1] | |
| Collector saturation voltage | | | | | |
| at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{CEsat}$ | | 0.07 (< 0.2) | | V |
| at $I_C = 100$ mA, $I_B = 5$ mA | $V_{CEsat}$ | | 0.2 (< 0.6)[1] | | V |
| Base saturation voltage | | | | | |
| at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{BEsat}$ | | 0.73 (< 0.83) | | V |
| at $I_C = 100$ mA, $I_B = 5$ mA | $V_{BEsat}$ | | 0.87 (< 1.05)[1] | | V |
| Base emitter voltage | | | | | |
| at $V_{CE} = 5$ V, $I_C = 0.1$ mA | $V_{BE}$ | | 0.55 | | V |
| at $V_{CE} = 5$ V, $I_C = 2$ mA | $V_{BE}$ | | 0.62 (0.55 . . . 0.7) | | V |
| at $V_{CE} = 5$ V, $I_C = 100$ mA | $V_{BE}$ | | 0.83[1] | | V |

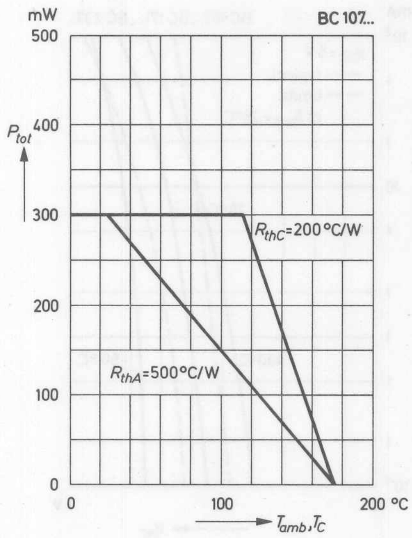
| | | **BC 107**<br>**BC 171**<br>**BC 237** | **BC 108**<br>**BC 109**<br>**BC 172**<br>**BC 173**<br>**BC 238**<br>**BC 239** | **BC 190**<br>**BC 174** | |
|---|---|---|---|---|---|
| Collector cutoff current | | | | | |
| at $V_{CE} = 60$ V | $I_{CES}$ | – | – | 0.2 (< 15) | nA |
| at $V_{CE} = 50$ V | $I_{CES}$ | 0.2 (< 15) | – | – | nA |
| at $V_{CE} = 30$ V | $I_{CES}$ | – | 0.2 (< 15) | – | nA |
| at $V_{CE} = 60$ V, $T_{amb} = 125\,°C$ | $I_{CES}$ | – | – | 0.2 (< 4) | µA |
| at $V_{CE} = 50$ V, $T_{amb} = 125\,°C$ | $I_{CES}$ | 0.2 (< 4) | – | – | µA |
| at $V_{CE} = 30$ V, $T_{amb} = 125\,°C$ | $I_{CES}$ | – | 0.2 (< 4) | – | µA |
| Collector emitter breakdown voltage at $I_C = 2$ mA | $V_{(BR)CEO}$ | > 45 | > 25 | > 64 | V |
| Emitter base breakdown voltage at $I_E = 1$ µA | $V_{(BR)EBO}$ | > 6 | > 5 | > 5 | V |

[1] not valid for BC 109, BC 173 and BC 239

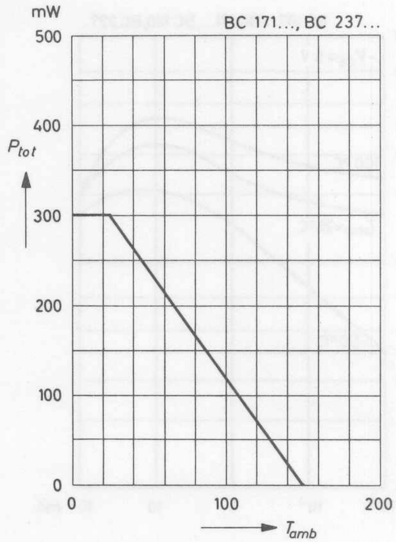
| | | | | |
|---|---|---|---|---|
| Gain bandwidth product | | | | |
| at $V_{CE} = 3$ V, $I_C = 0.5$ mA | | $f_T$ | 85 | MHz |
| at $V_{CE} = 5$ V, $I_C = 10$ mA<br>$f = 100$ MHz | | $f_T$ | 250 (> 150) | MHz |
| Collector base capacitance<br>at $V_{CBO} = 10$ V, $f = 1$ MHz | | $C_{CBO}$ | 3.5 (< 6) | pF |
| Emitter base capacitance<br>at $V_{EBO} = 0.5$ V, $f = 1$ MHz | | $C_{EBO}$ | 8 | pF |
| **BC 107, BC 108, BC 171, BC 172**<br>**BC 174, BC 190, BC 237, BC 238:**<br>Noise figure<br>at $V_{CE} = 5$ V, $I_C = 0.2$ mA,<br>$R_G = 2$ kΩ, $f = 1$ kHz | | $F$ | 2 (< 10) | dB |
| **BC 109, BC 173 and BC 239:**<br>Noise figure<br>at $V_{CE} = 5$ V, $I_C = 0.2$ mA,<br>$R_G = 2$ kΩ, $f = 1$ kHz | | $F$ | < 4 | dB |
| Noise figure<br>at $V_{CE} = 5$ V, $I_C = 0.2$ mA,<br>$R_G = 2$ kΩ, $f = 30$ Hz . . . 15 kHz | | $F$ | < 4 | dB |
| | | **TO-92** | **TO-18** | |
| Thermal resistance | | | | |
| Junction to case | $R_{thC}$ | – | < 200 | °C/W |
| Junction to ambient air | $R_{thA}$ | < 420[1] | < 500 | °C/W |

[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

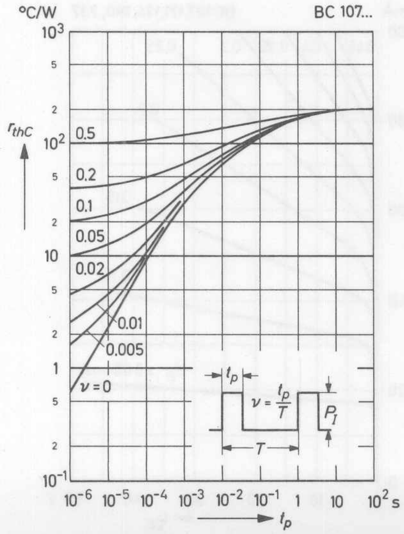
**Admissible power dissipation versus temperature**



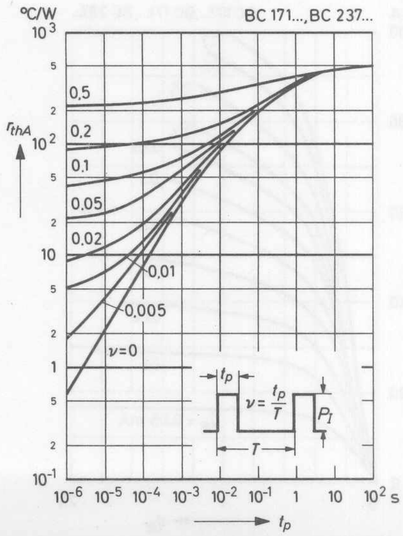

**Admissible power dissipation versus ambient temperature**
(see note on page 34)



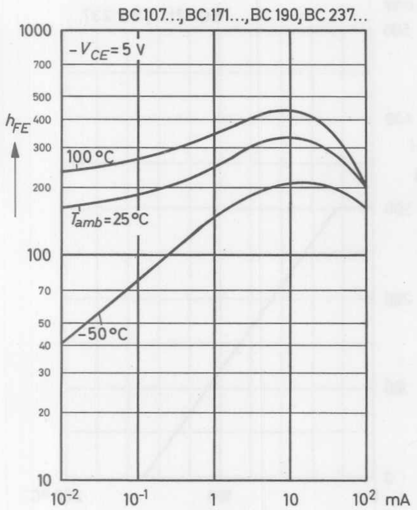

**Pulse thermal resistance versus pulse duration**



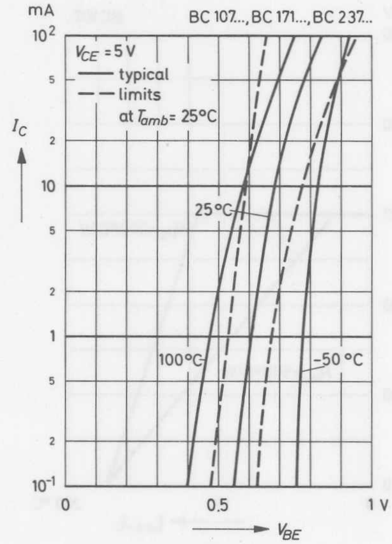

**Pulse thermal resistance versus pulse duration**
(see note on page 34)



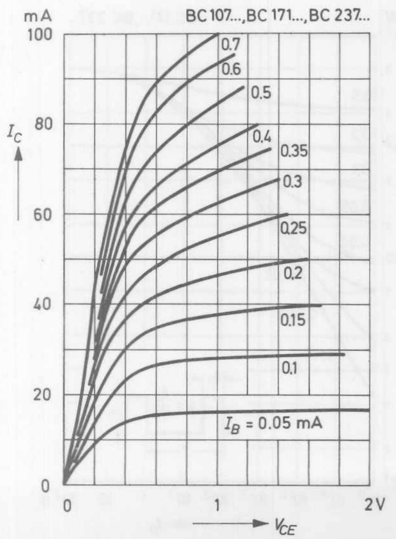
**DC current gain versus collector current**



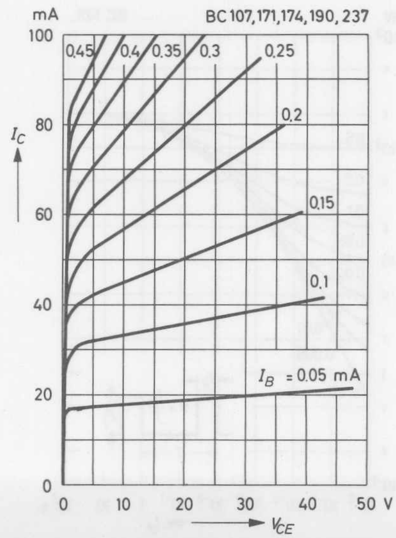

**Collector current versus base emitter voltage**



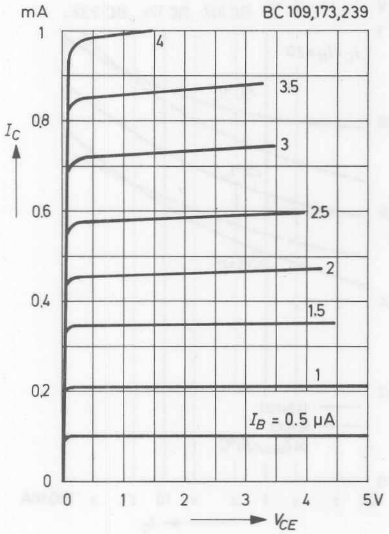

**Common emitter collector characteristics**



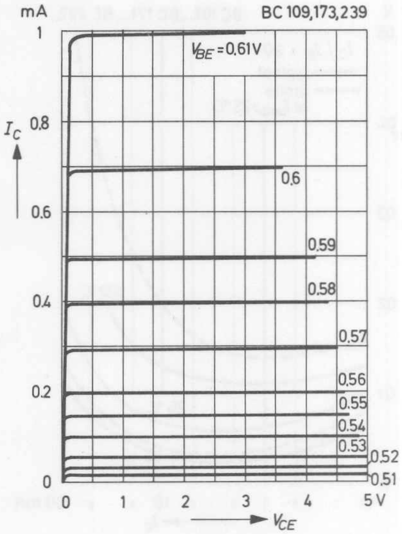

**Common emitter collector characteristics**



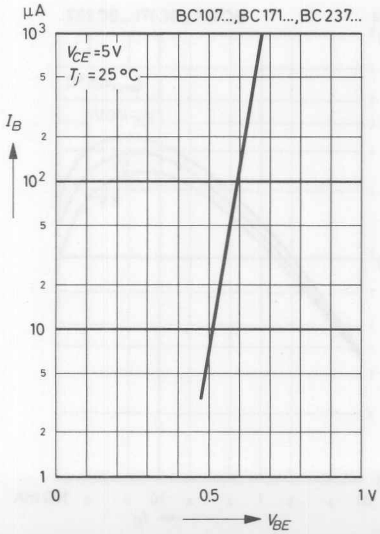
**Common emitter collector characteristics**



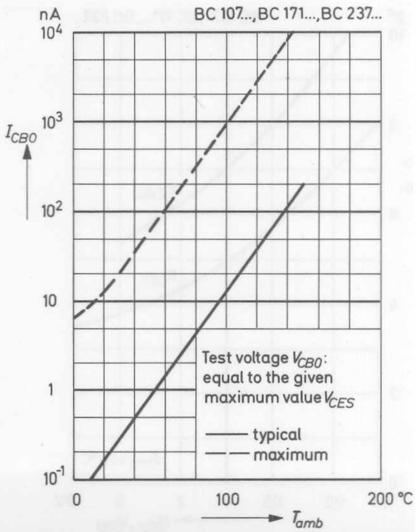

**Common emitter collector characteristics**



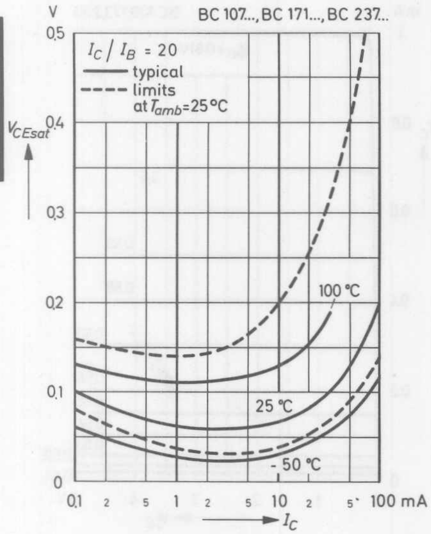

**Common emitter input characteristic**



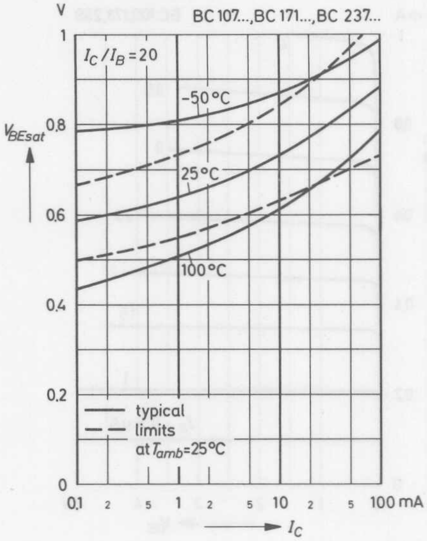

**Collector cutoff current versus ambient temperature**



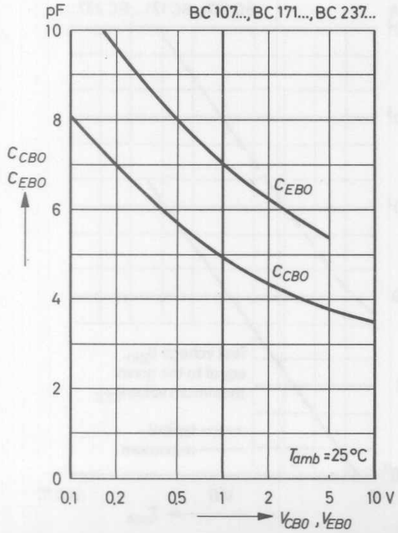
**Collector saturation voltage versus collector current**



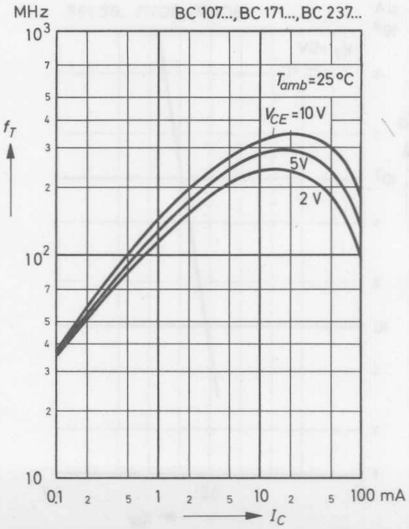

**Base saturation voltage versus collector current**



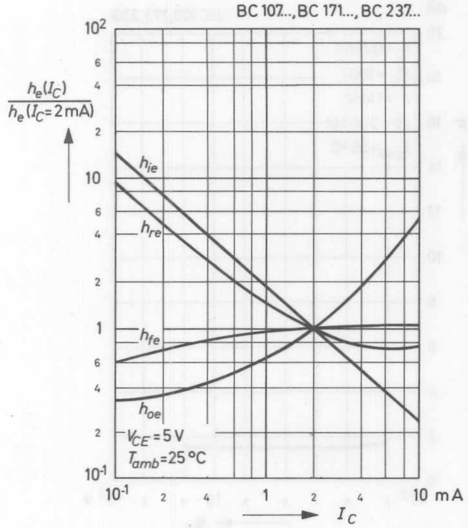

**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



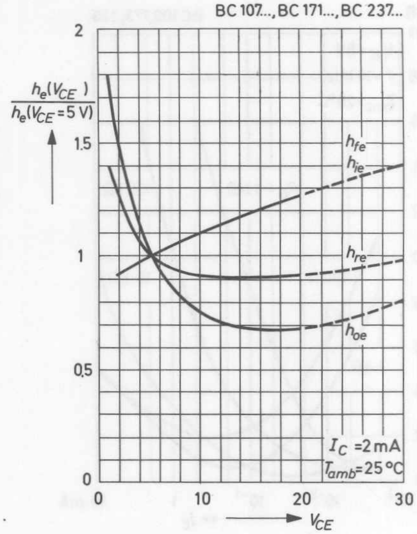

**Gain bandwidth product versus collector current**



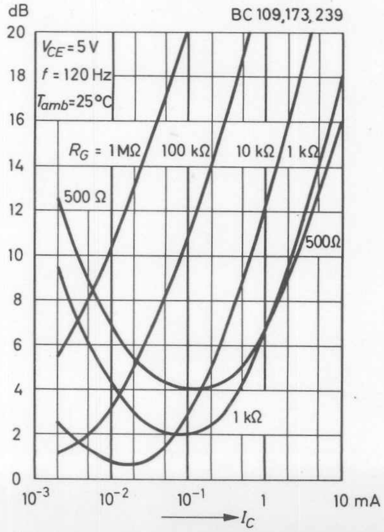
**Relative *h*-parameters versus collector current**



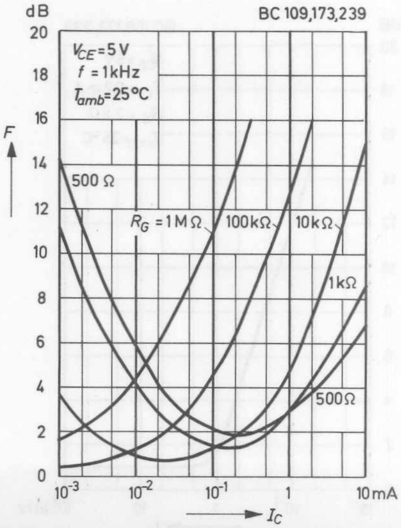

**Relative *h*-parameters versus collector emitter voltage**



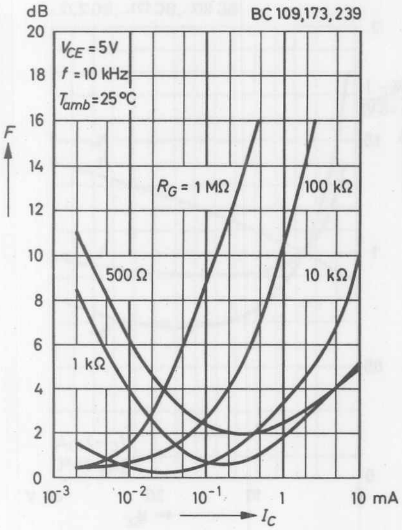

**Noise figure versus collector current**



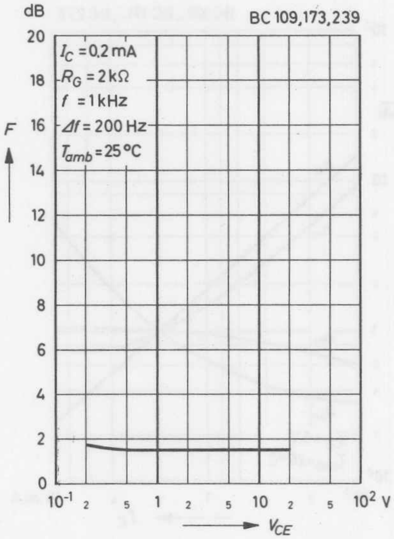

**Noise figure versus collector current**



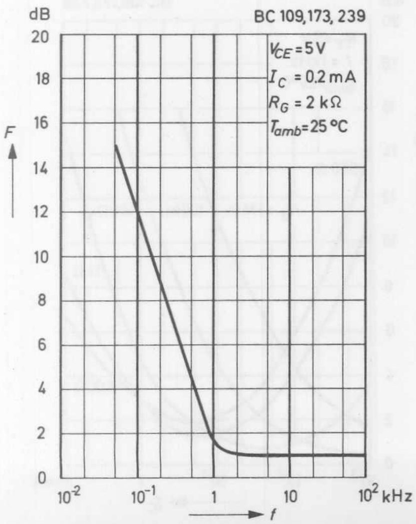
**Noise figure versus collector curent**




**Noise figure versus collector emitter voltage**



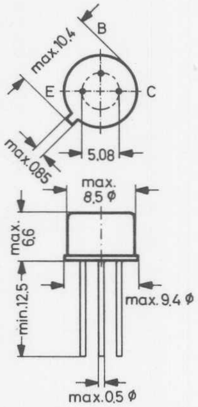

**Noise figure versus frequency**



# BC 140, BC 141

**NPN Silicon Epitaxial Planar Transistors**
for switching and amplifier applications

These types are subdivided into three groups –6, –10 and –16, according to their DC current gain. As complementary types the PNP transistors BC 160 and BC 161 are recommended.



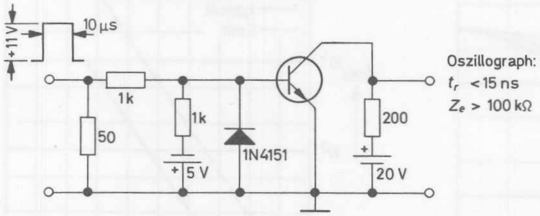

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

| **Maximum Ratings** | | **BC 140** | | **BC 141** | V |
|---|---|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 80 | | 100 | V |
| Collector emitter voltage | $V_{CEO}$ | 40 | | 60 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | | 7 | A |
| Collector current | $I_C$ | | 1 | | A |
| Base current | $I_B$ | | 0.1 | | |
| Power dissipation | | | | | W<br>W |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | | 0.75 | | |
| at $T_C$ = 45 °C | $P_{tot}$ | | 3.7 | | |
| Junction temperature | $T_j$ | | 175 | | °C |
| Storage temperature range | $T_S$ | | –55 ... +175 | | °C |

| **Characteristics** at $T_j$ = 25 °C | | **BC 140-6**<br>**BC 141-6** | **BC 140-10**<br>**BC 141-10** | **BC 140-16**<br>**BC 141-16** | |
|---|---|---|---|---|---|
| DC current gain | | | | | |
| at $V_{CE}$ = 1 V, $I_C$ = 0.1 mA | $h_{FE}$ | 28 | 40 | 90 | |
| at $V_{CE}$ = 1 V, $I_C$ = 100 mA | $h_{FE}$ | 63<br>(40 ... 100) | 100<br>(63 ... 160) | 160<br>(100 ... 250) | |
| at $V_{CE}$ = 1 V, $I_C$ = 1 A | $h_{FE}$ | 15 | 20 | 30 | |
| Collector saturation voltage<br>at $I_C$ = 1 A, $I_B$ = 100 mA | $V_{CE\,sat}$ | | 0.6 (< 1) | | V |
| Base emitter voltage<br>at $V_{CE}$ = 1 V, $I_C$ = 1 A | $V_{BE}$ | | 1.2 (< 1.8) | | V |

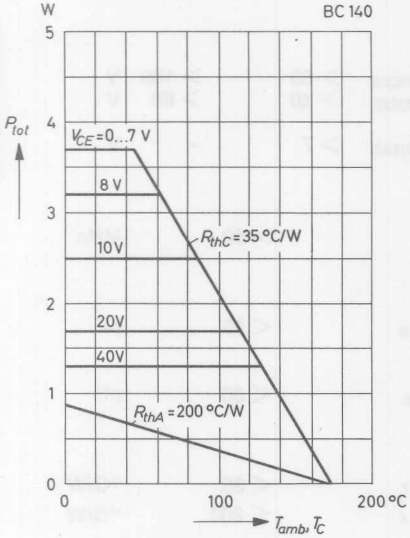
| | | BC 140 | BC 141 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $V_{CE} = 40$ V | $I_{CES}$ | 10 (< 100) | – | nA |
| at $V_{CE} = 60$ V | $I_{CES}$ | – | 10 (< 100) | nA |
| at $V_{CE} = 40$ V, $T_j = 150$ °C | $I_{CES}$ | 10 (< 100) | – | μA |
| at $V_{CE} = 60$ V, $T_j = 150$ °C | $I_{CES}$ | – | 10 (< 100) | μA |
| Collector emitter breakdown voltage | | | | |
| at $I_C = 0.1$ mA | $V_{(BR)CES}$ | > 80 | > 100 | V |
| at $I_C = 30$ mA (pulsed 200 μs, 1 %) | $V_{(BR)CEO}$ | > 40 | > 60 | V |
| Emitter base breakdown voltage at $I_E = 0.1$ mA | $V_{(BR)EBO}$ | > 7 | – | V |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 20$ MHz | $f_T$ | > 50 | | MHz |
| Collector base capacitance at $V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | < 25 | | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V, $f = 1$ MHz | $C_{EBO}$ | < 80 | | pF |
| Thermal resistance | | | | |
| Junction to case | $R_{th\,C}$ | < 35 | | °C/W |
| Junction to ambient air | $R_{th\,A}$ | < 200 | | °C/W |
| **Switching Times** at $I_C = 100$ mA, $I_{B1} \approx -I_{B2} \approx 5$ mA | | | | |
| Turn-on time | $t_{on}$ | < 250 | | ns |
| Turn-off time | $t_{off}$ | < 850 | | ns |

**Test Circuit for Switching Times**

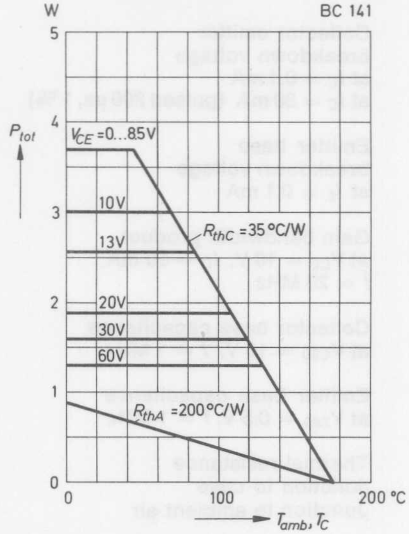



Rise time and fall time of input voltage < 15 ns, generator impedance 50 Ω

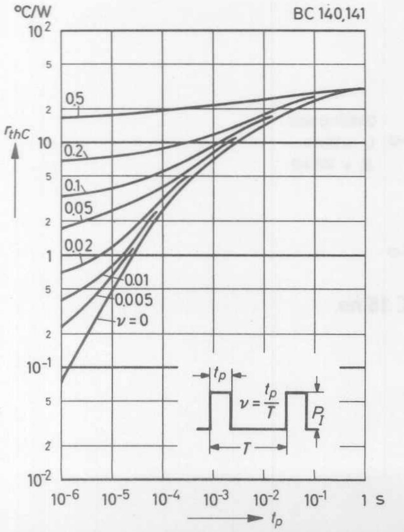
**Admissible power dissipation versus temperature**



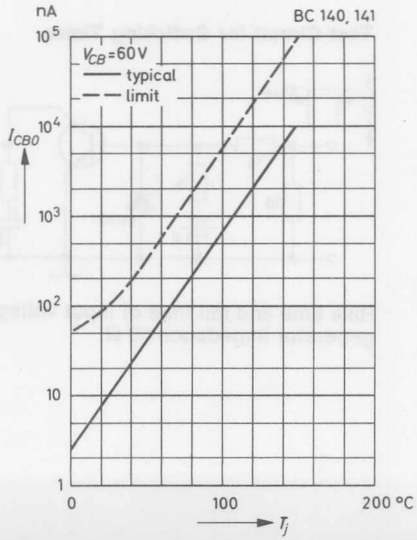

**Admissible power dissipation versus temperature**



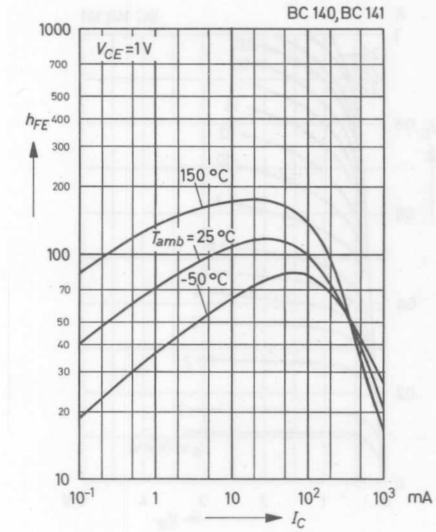

**Pulse thermal resistance versus pulse duration**



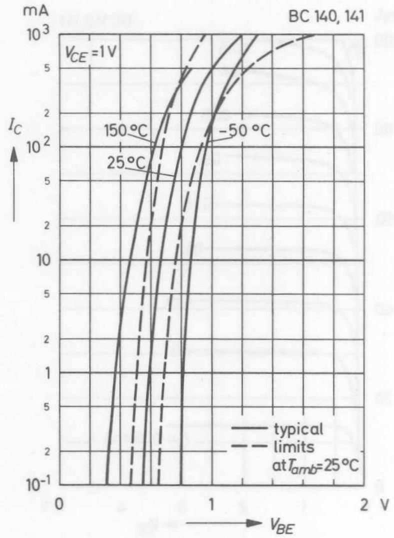

**Collector cutoff current versus junction temperature**



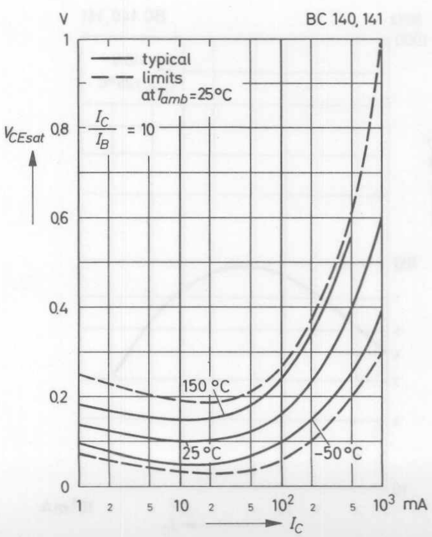
**DC current gain versus collector current**



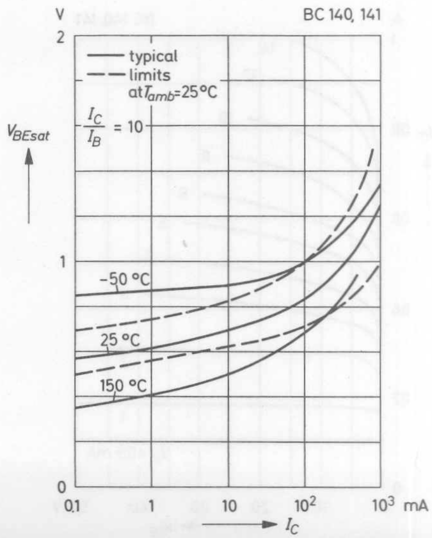

**Collector current versus base emitter voltage**



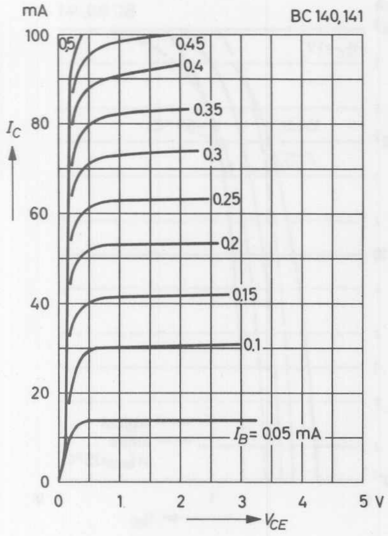

**Collector saturation voltage versus collector current**



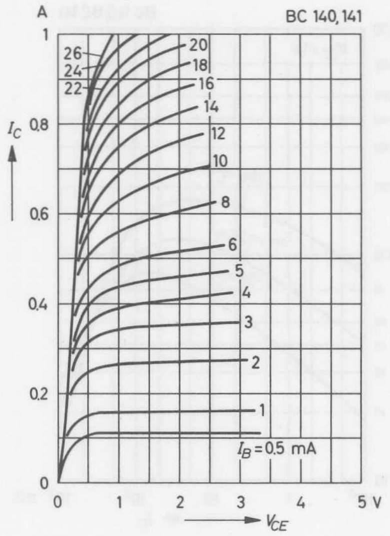

**Base saturation voltage versus collector current**



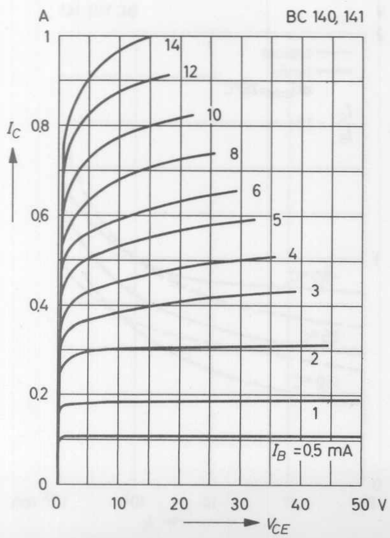
**Common emitter collector characteristics**



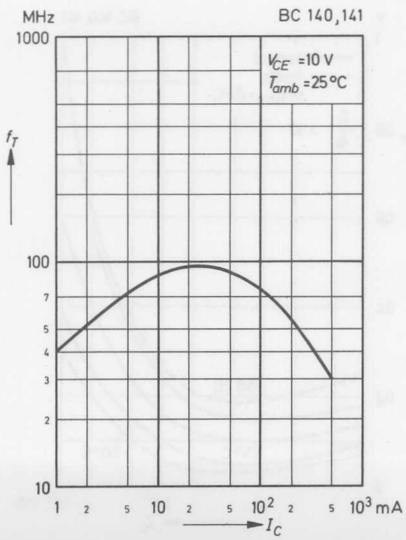

**Common emitter collector characteristics**




**Common emitter collector characteristics**

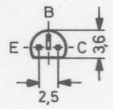



**Gain bandwidth product versus collector current**

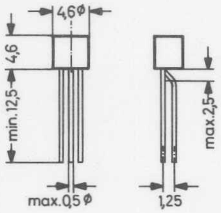


**NPN Silicon Planar Transistor**
for switching and amplifier applications

The transistors are subdivided into three groups, A, B and C, according to their DC current gain.




Plastic package ≈ JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm




**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 20 | V |
| Collector emitter voltage | $V_{CEO}$ | 20 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 100 | mA |
| Power dissipation at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | 300 [1] | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | $-55 \dots +150$ | °C |

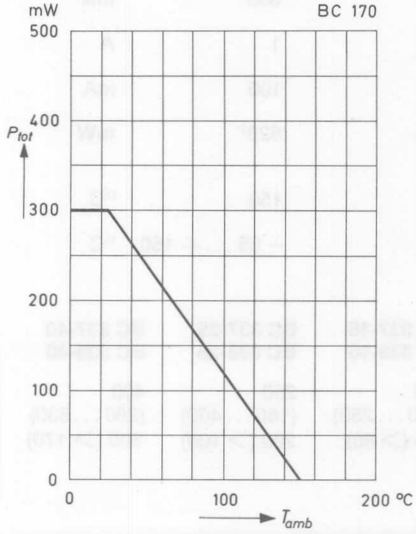
**Characteristics** at $T_{amb} = 25\ ^\circ C$

| | | BC 170 A | BC 170 B | BC 170 C | |
|---|---|---|---|---|---|
| DC current gain | | | | | |
| at $V_{CE} = 1$ V, $I_C = 1$ mA | $h_{FE}$ | 35 . . . 100 | 80 . . . 250 | 200 . . . 600 | |
| at $V_{CE} = 1$ V, $I_C = 30$ mA | $h_{FE}$ | $> 30$ | $> 60$ | $> 150$ | |
| Collector saturation voltage | | | | | |
| at $I_C = 1$ mA, $I_B = 0.1$ mA | | | $V_{CE\,sat}$ | $< 0.25$ | V |
| at $I_C = 30$ mA, $I_B = 3$ mA | | | $V_{CE\,sat}$ | $< 0.4$ | V |
| Base saturation voltage at $I_C = 1$ mA, $I_B = 0.1$ mA | | | $V_{BE\,sat}$ | $< 0.7$ | V |
| Collector cutoff current at $V_{CB} = 15$ V | | | $I_{CBO}$ | $< 0.1$ | µA |

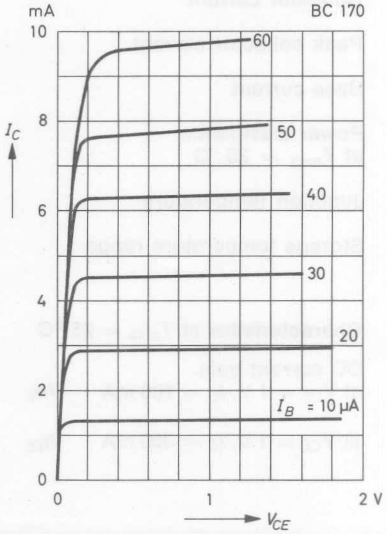
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | |
|---|---|---|---|
| Emitter cutoff current at $V_{EB} = 4$ V | $I_{EBO}$ | < 0.1 | μA |
| Collector base capacitance at $V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | 4 | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V, $f = 1$ MHz | $C_{EBO}$ | 12 | pF |
| Gain bandwidth product at $V_{CE} = 5$ V, $I_C = 10$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |
| Noise figure at $V_{CE} = 5$ V, $I_C = 0.2$ mA, $R_G = 2$ kΩ, $f = 1$ kHz, $\Delta f = 200$ Hz | $F$ | < 10 | dB |
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 420 [1] | °C/W |

**Admissible power dissipation versus ambient temperature** [1]




**Common emitter collector characteristics**



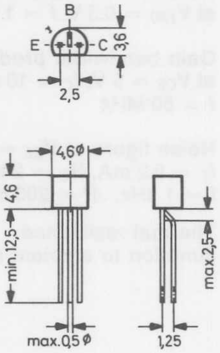

[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

# BC 337, BC 338

**NPN Silicon Epitaxial Planar Transistors**
for switching and amplifier applications. Especially suitable for AF-driver stages and low power output stages.

These types are subdivided into three groups -16, -25 and -40, according to their DC current gain. As complementary types the PNP transistors BC 327 and BC 328 are recommended.

Plastic case ≈ JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm



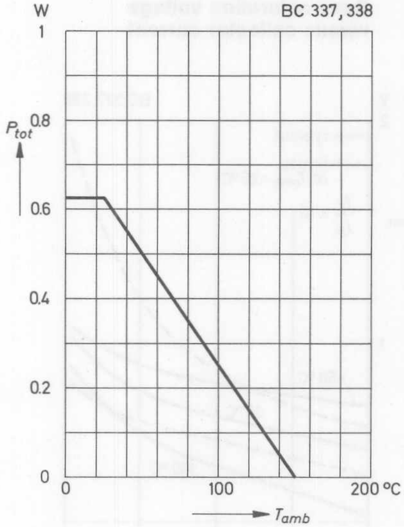

| **Maximum Ratings** | | **BC 337** | **BC 338** | |
|---|---|---|---|---|
| Collector emitter voltage | $V_{CES}$ | 50 | 30 | V |
| Collector emitter voltage | $V_{CEO}$ | 45 | 25 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | | V |
| Collector current | $I_C$ | 800 | | mA |
| Peak collector current | $I_{CM}$ | 1 | | A |
| Base current | $I_B$ | 100 | | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 625[1] | | mW |
| Junction temperature | $T_j$ | 150 | | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +150$ | | °C |

| **Characteristics** at $T_{amb} = 25\ °C$ | | **BC 337-16** **BC 338-16** | **BC 337-25** **BC 338-25** | **BC 337-40** **BC 338-40** |
|---|---|---|---|---|
| DC current gain at $V_{CE} = 1$ V, $I_C = 100$ mA | $h_{FE}$ | 160 (100 ... 250) | 250 (160 ... 400) | 400 (250 ... 630) |
| at $V_{CE} = 1$ V, $I_C = 300$ mA | $h_{FE}$ | 130 (> 60) | 200 (> 100) | 300 (> 170) |

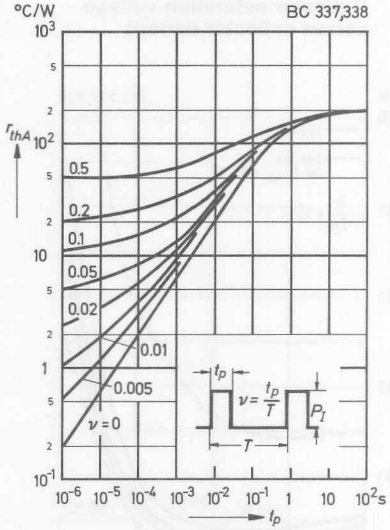
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | BC 337 | BC 338 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $V_{CE} = 25$ V | $I_{CES}$ | – | 2 (< 100) | nA |
| at $V_{CE} = 45$ V | $I_{CES}$ | 2 (< 100) | – | nA |
| at $V_{CE} = 25$ V, $T_{amb} = 125$ °C | $I_{CES}$ | – | < 10 | $\mu$A |
| at $V_{CE} = 45$ V, $T_{amb} = 125$ °C | $I_{CES}$ | < 10 | – | $\mu$A |
| Collector emitter breakdown voltage at $I_C = 10$ mA | $V_{(BR)CEO}$ | > 45 | > 20 | V |
| Collector emitter breakdown voltage at $I_C = 0.1$ mA | $V_{(BR)CES}$ | > 50 | > 30 | V |
| Emitter base breakdown voltage at $I_E = 0.1$ mA | $V_{(BR)EBO}$ | > 5 | | V |
| Collector saturation voltage at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | < 0,7 | | V |
| Base emitter voltage at $V_{CE} = 1$ V, $I_C = 300$ mA | $V_{BE}$ | < 1,2 | | V |
| Gain bandwidth product at $V_{CE} = 5$ V, $I_C = 10$ mA, $f = 50$ MHz | $f_T$ | 100 | | MHz |
| Collector base capacitance at $V_{CB} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | 12 | | pF |
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 200 [1] | | °C/W |

**Admissible power dissipation versus ambient temperature [1])**

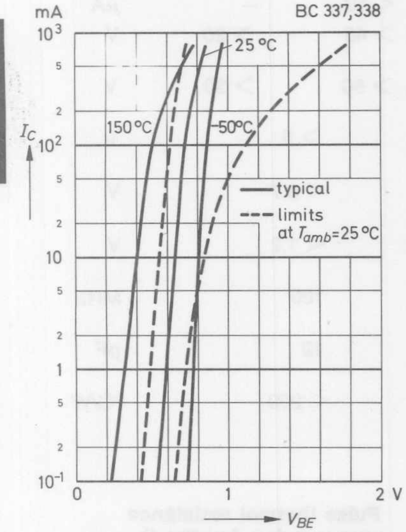



**Pulse thermal resistance versus pulse duration [1])**

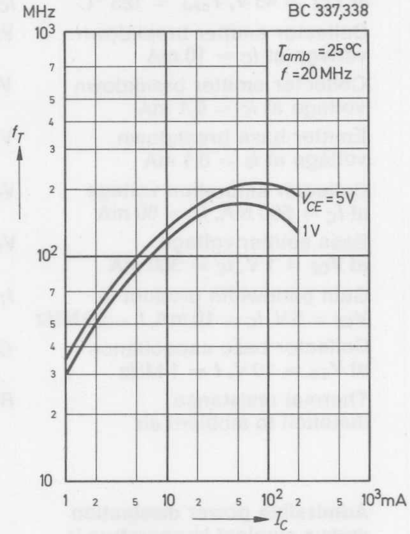



[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

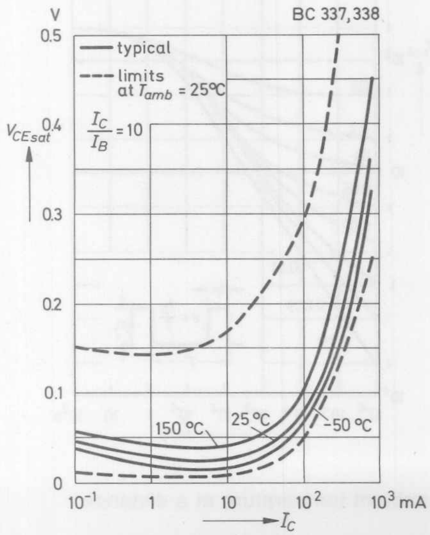
**Collector current versus base emitter voltage**



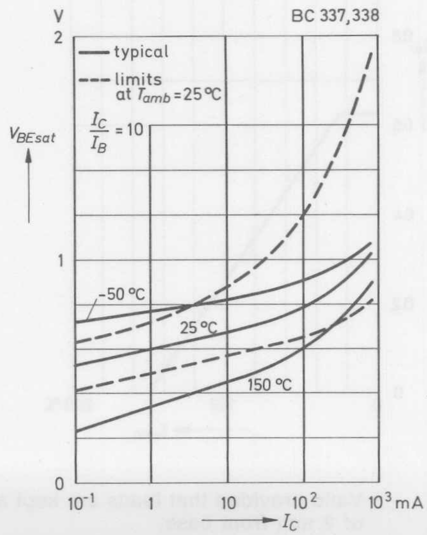

**Gain bandwidth product versus collector current**



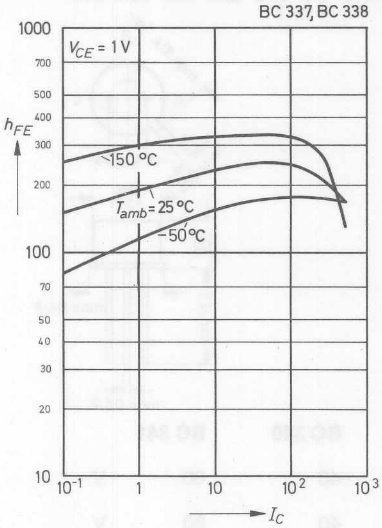

**Collector saturation voltage versus collector current**



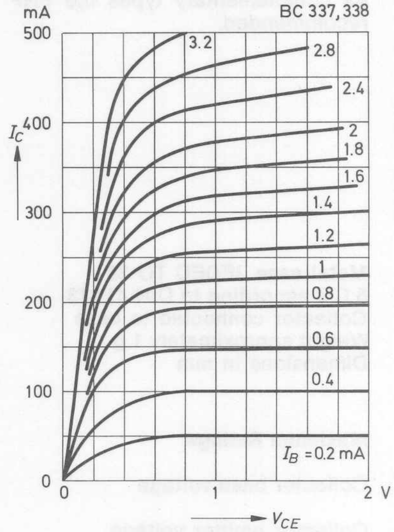

**Base saturation voltage versus collector current**



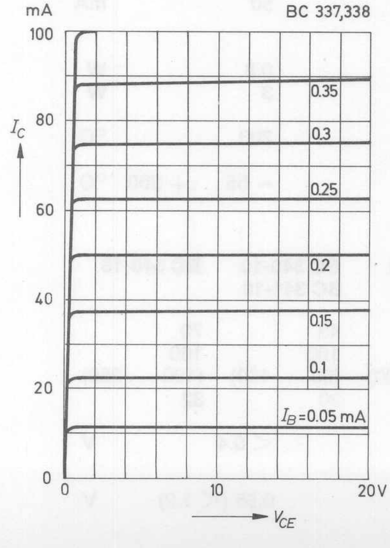
**DC current gain versus collector current**



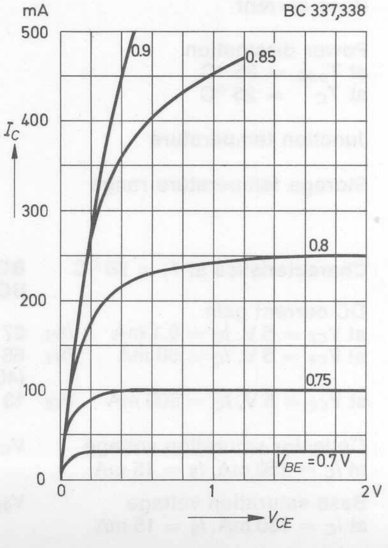

**Common emitter collector characteristics**




**Common emitter collector characteristics**




**Common emitter collector characteristics**



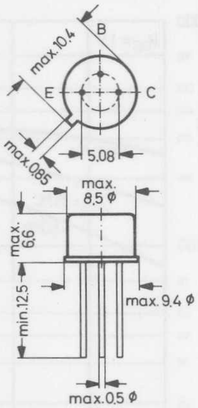
# BC 340, BC 341

**NPN Silicon Epitaxial Planar Transistors**

for switching and amplifier applications

The type BC 340 is subdivided into three groups, -6, -10 and -16, the type BC 341 into two groups, -6 and -10, according to the DC current gain.

As complementary types the PNP transistors BC 360 and BC 361 are recommended.



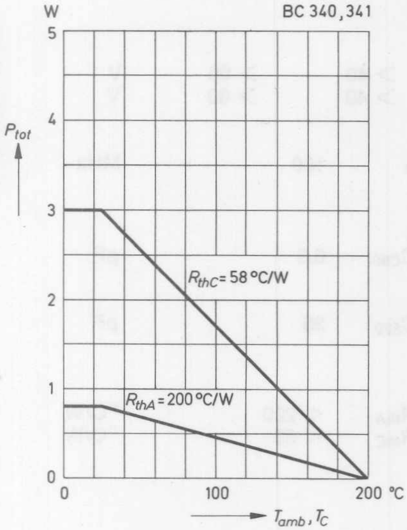

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

| **Maximum Ratings** | | **BC 340** | **BC 341** | |
|---|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | 60 | V |
| Collector emitter voltage | $V_{CEO}$ | 40 | 60 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | 5 | V |
| Collector current | $I_C$ | 500 | | mA |
| Base current | $I_B$ | 50 | | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 3 | | W |
| Junction temperature | $T_j$ | 200 | | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +200$ | | °C |

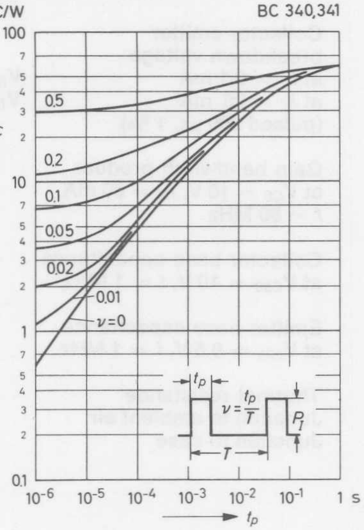
| **Characteristics** at $T_j = 25\ °C$ | | **BC 340-6** **BC 341-6** | **BC 340-10** **BC 341-10** | **BC 340-16** | |
|---|---|---|---|---|---|
| DC current gain at $V_{CE} = 5$ V, $I_C = 0.1$ mA | $h_{FE}$ | 27 | 43 | 70 | |
| at $V_{CE} = 5$ V, $I_C = 50$ mA | $h_{FE}$ | 63 (40 . . . 100) | 100 (63 . . . 160) | 160 (100 . . . 250) | |
| at $V_{CE} = 5$ V, $I_C = 500$ mA | $h_{FE}$ | 13 | 20 | 32 | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | | $< 0.4$ | | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | | 0.95 ($< 1.2$) | | V |

| | | BC 340 | BC 341 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $V_{CE} = 40$ V | $I_{CES}$ | 10 (< 100) | – | nA |
| at $V_{CE} = 60$ V | $I_{CES}$ | – | 10 (< 100) | nA |
| at $V_{CE} = 40$ V, $T_j = 150$ °C | $I_{CES}$ | 10 (< 100) | – | μA |
| at $V_{CE} = 60$ V, $T_j = 150$ °C | $I_{CES}$ | – | 10 (< 100) | μA |
| Collector emitter breakdown voltage | | | | |
| at $I_C = 0.1$ mA | $V_{(BR)CES}$ | > 40 | > 60 | V |
| at $I_C = 30$ mA (pulsed 200 μs, 1 %) | $V_{(BR)CEO}$ | > 40 | > 60 | V |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | | MHz |
| Collector base capacitance at $V_{CB0} = 10$ V, $f = 1$ MHz | $C_{CB0}$ | 6.5 | | pF |
| Emitter base capacitance at $V_{EB0} = 0.5$ V, $f = 1$ MHz | $C_{EB0}$ | 25 | | pF |
| Thermal resistance | | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | | °C/W |
| Junction to case | $R_{thC}$ | < 58 | | °C/W |

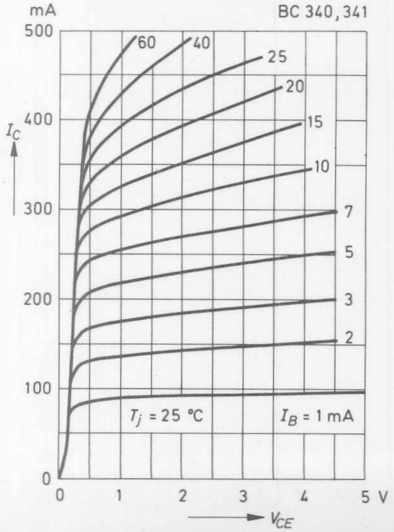
**Admissible power dissipation versus temperature**



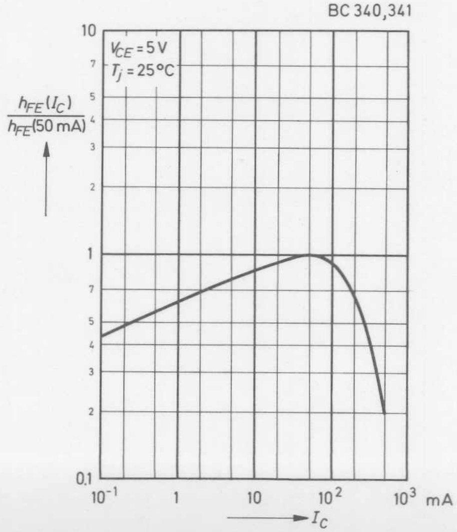

**Pulse thermal resistance versus pulse duration**



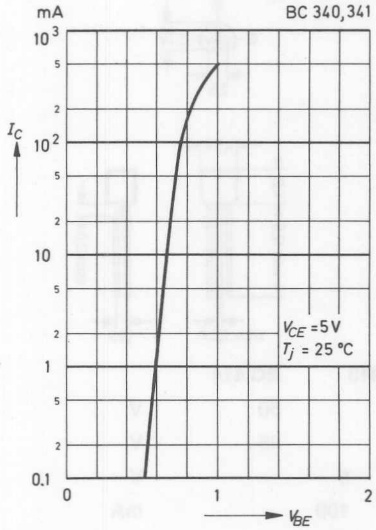

**Common emitter collector characteristics**



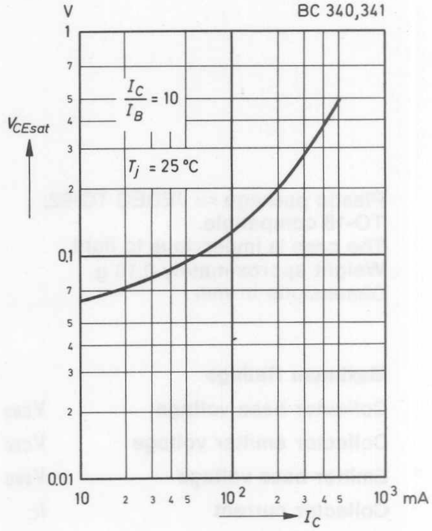

**Relative DC current gain versus collector current**



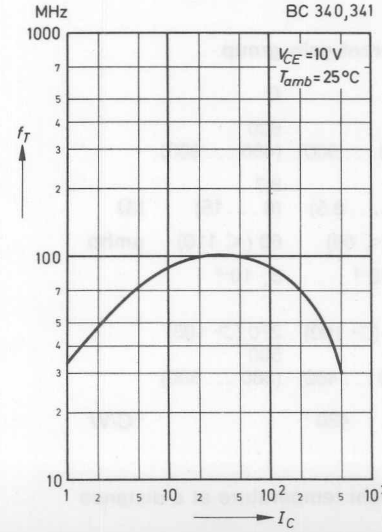
**Collector current versus base emitter voltage**



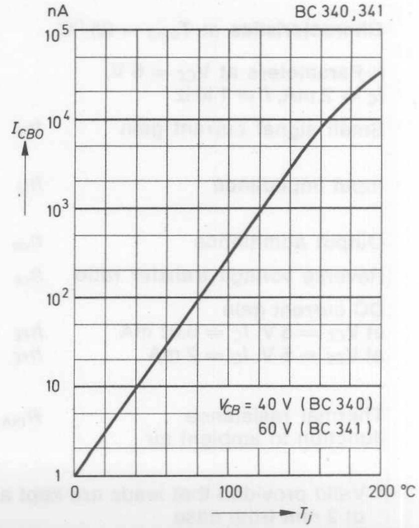

**Collector saturation voltage versus collector current**




**Gain bandwidth product versus collector current**



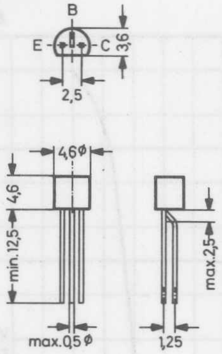

**Collector cutoff current versus junction temperature**



# BC 413, BC 414

**NPN Silicon Epitaxial Planar Transistors**
for use in high-quality, low-noise AF and DC amplifiers. Complementary types are the PNP transistors BC 415 and BC 416.

These types are subdivided into two groups B and C according to their current gain.




Plastic package ≈ JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

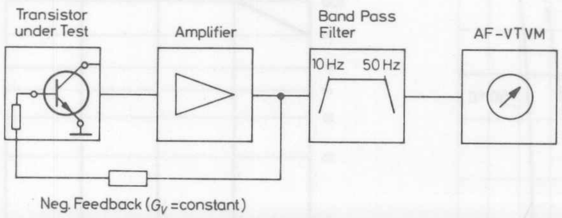
| **Maximum Ratings** | | **BC 413** | **BC 414** | |
|---|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 45 | 50 | V |
| Collector emitter voltage | $V_{CEO}$ | 30 | 45 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | | V |
| Collector current | $I_C$ | 100 | | mA |
| Base current | $I_B$ | 20 | | mA |
| Power dissipation at $T_{amb}$ = 25 °C | $P_{tot}$ | 300 [1] | | mW |
| Junction temperature | $T_j$ | 150 | | °C |
| Storage temperature range | $T_S$ | −65 ... +150 | | °C |

**Characteristics** at $T_{amb}$ = 25 °C

| | | **Current gain group** | | |
|---|---|---|---|---|
| $h$-Parameters at $V_{CE}$ = 5 V, $I_C$ = 2 mA, $f$ = 1 kHz | | **B** | **C** | |
| Small signal current gain | $h_{fe}$ | 330<br>(240 ... 500) | 600<br>(450 ... 900) | |
| Input impedance | $h_{ie}$ | 4.5<br>(3.2 ... 8.5) | 8.7<br>(6 ... 15) | kΩ |
| Output admittance | $h_{oe}$ | 30 (< 60) | 60 (< 110) | μmho |
| Reverse voltage transfer ratio | $h_{re}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |
| DC current gain<br>at $V_{CE}$ = 5 V, $I_C$ = 0.01 mA | $h_{FE}$ | 150 (> 100) | 270 (> 100) | |
| at $V_{CE}$ = 5 V, $I_C$ = 2 mA | $h_{FE}$ | 290<br>(180 ... 460) | 500<br>(380 ... 800) | |
| Thermal resistance<br>Junction to ambient air | $R_{thA}$ | 420 [1] | | °C/W |

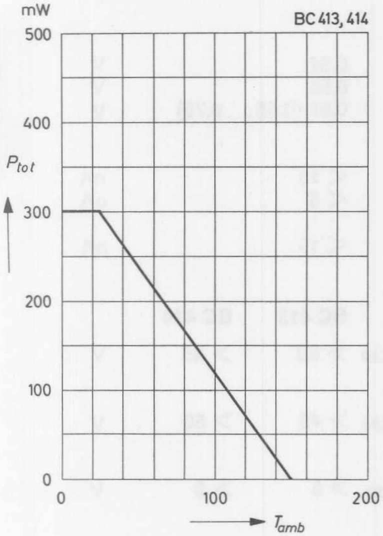
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case

| | | | | |
|---|---|---|---|---|
| Collector saturation voltage | | | | |
| at $I_C$ = 10 mA, $I_B$ = 0,5 mA | $V_{CE\,sat}$ | 0.075 (< 0.25) | | V |
| at $I_C$ = 100 mA, $I_B$ = 5 mA | $V_{CE\,sat}$ | 0.25 (< 0.6) | | V |
| Base saturation voltage at $I_C$ = 100 mA, $I_B$ = 5 mA | $V_{BE\,sat}$ | 0.9 | | V |
| Base emitter voltage | | | | |
| at $V_{CE}$ = 5 V, $I_C$ = 0.01 mA | $V_{BE}$ | 0.52 | | V |
| at $V_{CE}$ = 5 V, $I_C$ = 0.1 mA | $V_{BE}$ | 0.55 | | V |
| at $V_{CE}$ = 5 V, $I_C$ = 2 mA | $V_{BE}$ | 0.62 (0.55 ... 0.75) | | V |
| Collector cutoff current | | | | |
| at $V_{CB}$ = 30 V | $I_{CBO}$ | < 15 | | nA |
| at $V_{CB}$ = 30 V, $T_{amb}$ = 150 °C | $I_{CBO}$ | < 5 | | µA |
| Emitter cutoff current at $V_{EB}$ = 4 V | $I_{EBO}$ | < 15 | | nA |
| | | **BC 413** | **BC 414** | |
| Collector emitter breakdown voltage at $I_C$ = 10 mA | $V_{(BR)CEO}$ | > 30 | > 45 | V |
| Collector base breakdown voltage at $I_C$ = 10 µA | $V_{(BR)CBO}$ | > 45 | > 50 | V |
| Emitter base breakdown voltage at $I_E$ = 10 µA | $V_{(BR)EBO}$ | > 5 | > 5 | V |
| Gain bandwidth product at $V_{CE}$ = 5 V, $I_C$ = 10 mA, $f$ = 100 MHz | $f_T$ | 250 | | MHz |
| Collector base capacitance at $V_{CBO}$ = 10 V, $f$ = 1 MHz | $C_{CBO}$ | 2.5 | | pF |
| Noise figure at $V_{CE}$ = 5 V, $I_C$ = 0.2 mA, $R_G$ = 2 kΩ, $f$ = 30 Hz ... 15 kHz | $F$ | < 3 | | dB |
| Equivalent noise EMF (referred to base) at $V_{CE}$ = 5 V, $I_C$ = 0.2 mA, $R_G$ = 2 kΩ, $f$ = 10 ... 50 Hz | $v_r$ | < 0.135 | | µV |

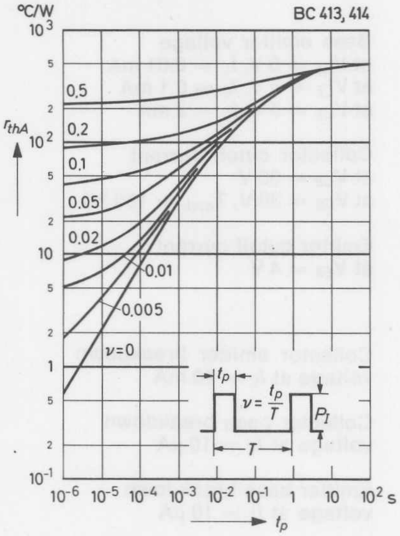



**Test circuit for equivalent noise EMF**

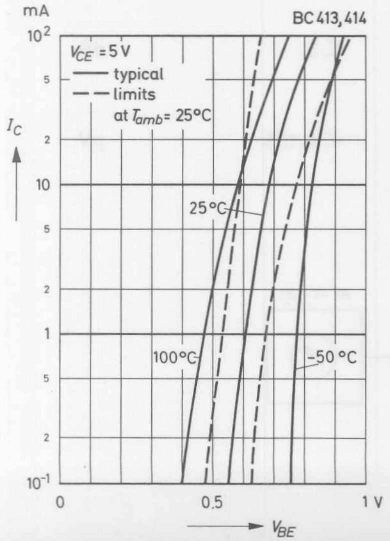
**Admissible power dissipation versus ambient temperature**
(see note on page 58)



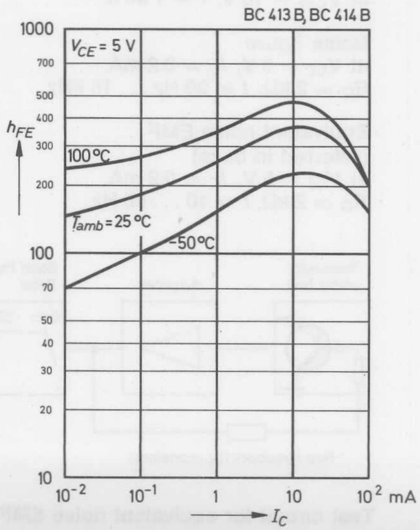

**Pulse thermal resistance versus pulse duration**
(see note on page 58)



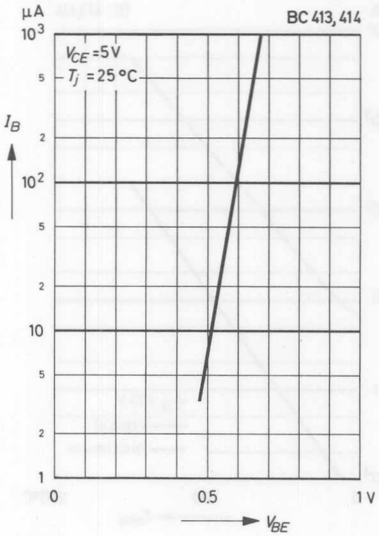

**Collector current versus base emitter voltage**



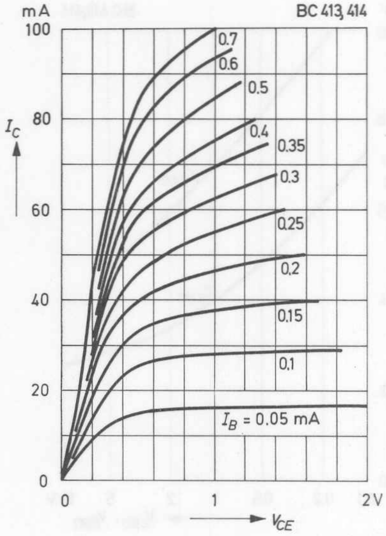

**DC current gain versus collector current**



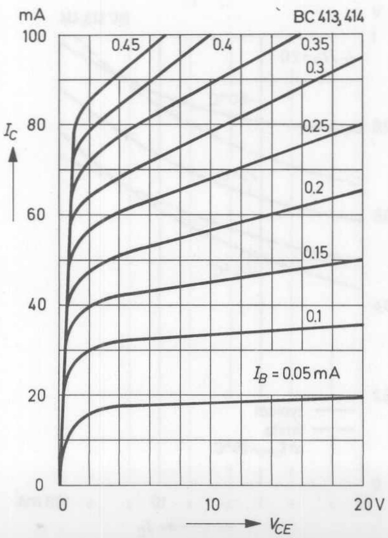
**Common emitter input characteristic**



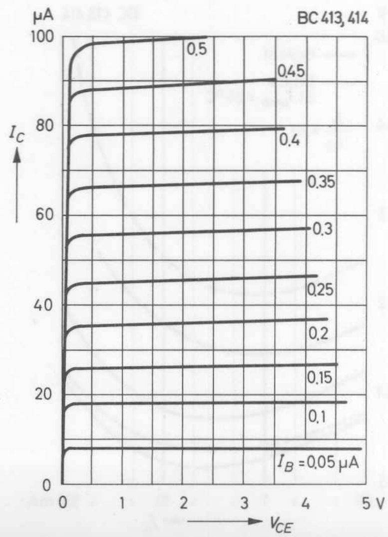

**Common emitter collector characteristics**



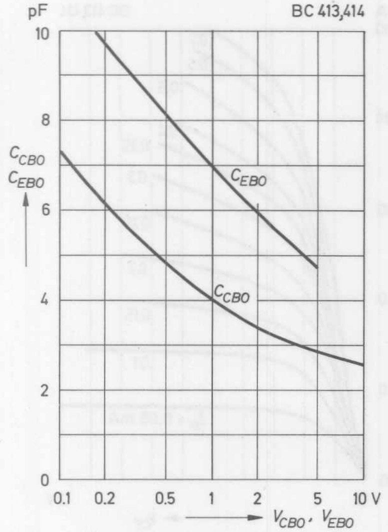

**Common emitter collector characteristics**



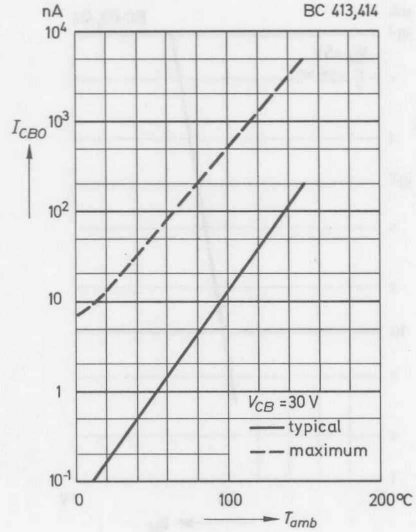

**Common emitter collector characteristics**



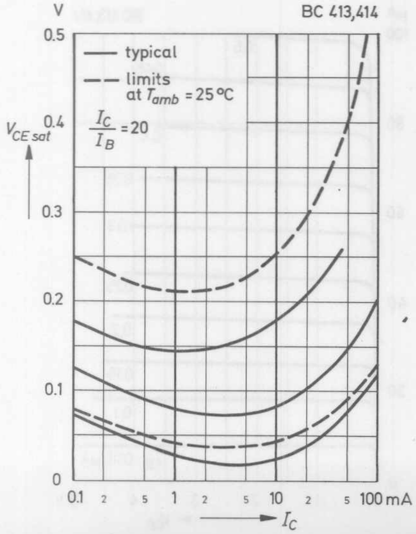
### Collector base capacitance, Emitter base capacitance versus reverse bias voltage



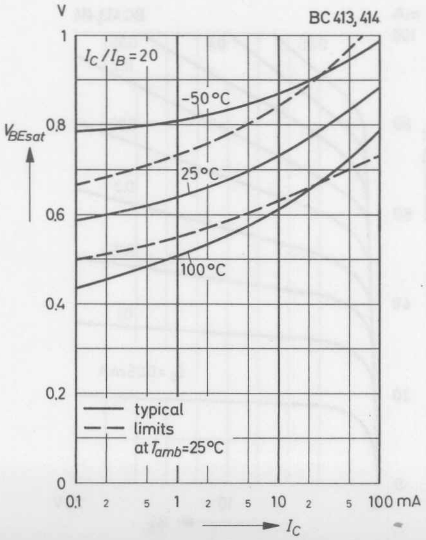

### Collector cutoff current versus ambient temperature



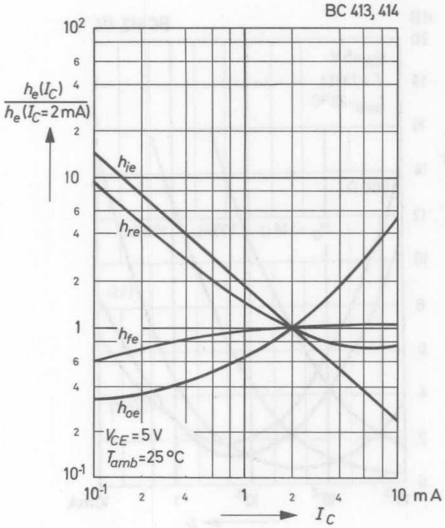

### Collector saturation voltage versus collector current



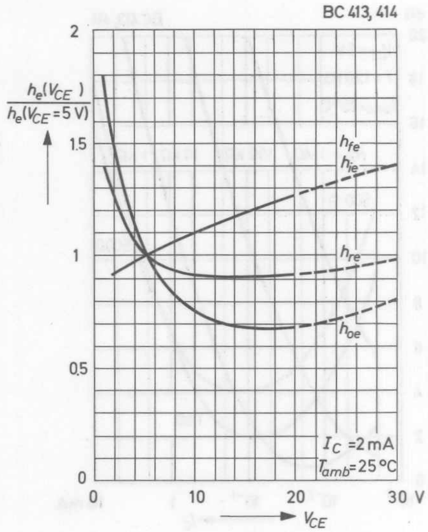

### Base saturation voltage versus collector current



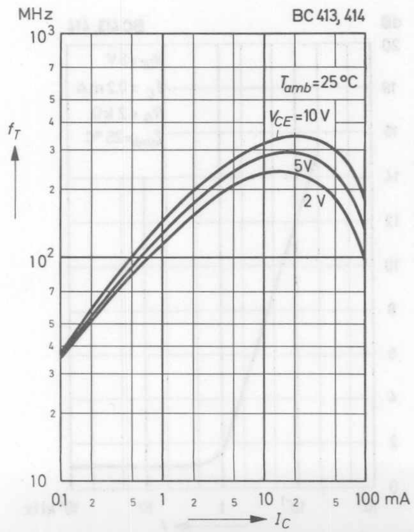
**Relative *h*-parameters versus collector current**



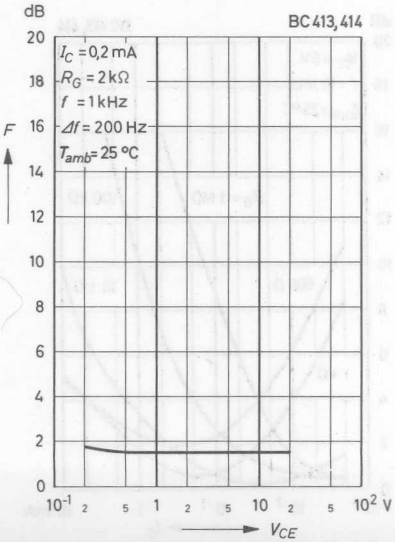

**Relative *h*-parameters versus collector emitter voltage**



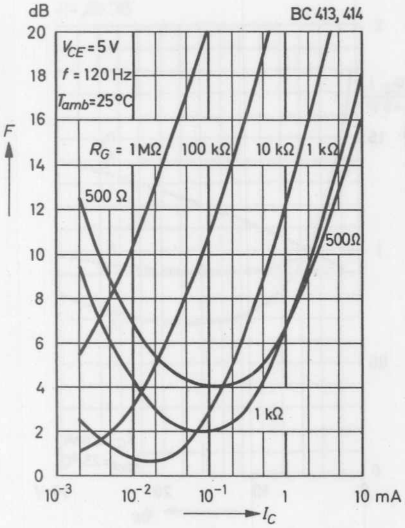

**Gain bandwidth product versus collector current**



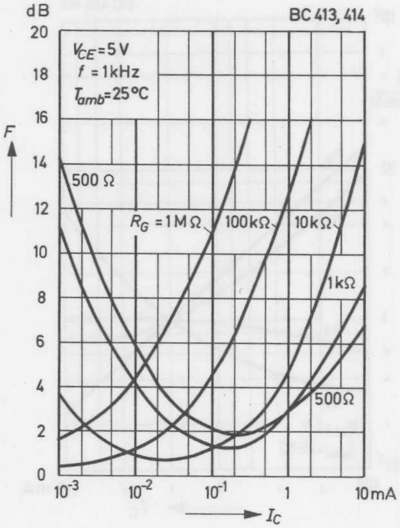

**Noise figure versus collector emitter voltage**



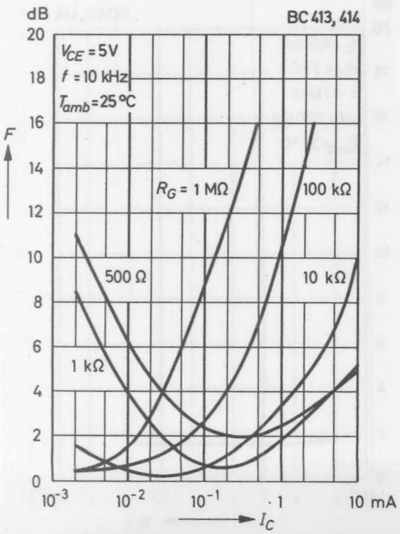
**Noise figure versus collector current**



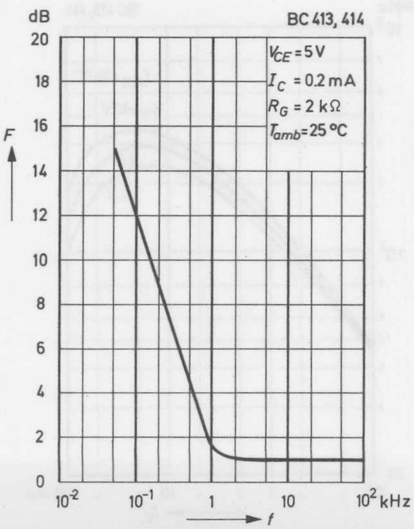

**Noise figure versus collector current**




**Noise figure versus collector current**



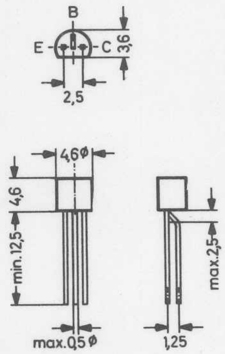

**Noise figure versus frequency**



## NPN Silicon Epitaxial Planar Transistors

for switching and AF amplifier applications.

These transistors are subdivided into three groups A, B and C according to their current gain. The types BC 546 and BC 547 are available in groups A and B, however, type BC 548 can be supplied in all three groups. The BC 549 and BC 550 are low noise types and available in groups B and C. As complementary types the PNP transistors BC 556 . . . BC 560 are recommended.




Plastic package ≈ JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

| **Maximum Ratings** | | **BC 546** | **BC 547**<br>**BC 550** | **BC 548**<br>**BC 549** | |
|---|---|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 80 | 50 | 30 | V |
| Collector emitter voltage | $V_{CES}$ | 80 | 50 | 30 | V |
| Collector emitter voltage | $V_{CEO}$ | 65 | 45 | 30 | V |
| Emitter base voltage | $V_{EBO}$ | 6 | 6 [1] | 5 | V |
| Collector current | $I_C$ | 100 | 100 | 100 | mA |
| Peak collector current | $I_{CM}$ | 200 | 200 | 200 | mA |
| Peak base current | $I_{BM}$ | 200 | 200 | 200 | mA |
| Peak emitter current | $-I_{EM}$ | 200 | 200 | 200 | mA |
| Power dissipation at $T_{amb} = 25$ °C | $P_{tot}$ | | 500 [2] | | mW |
| Junction temperature | $T_j$ | | 150 | | °C |
| Storage temperature range | $T_S$ | | $-65 \ldots +150$ | | °C |

[1]) BC 550: $V_{EBO} = 5$ V
[2]) Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

**Characteristics** at $T_{amb} = 25\ °C$

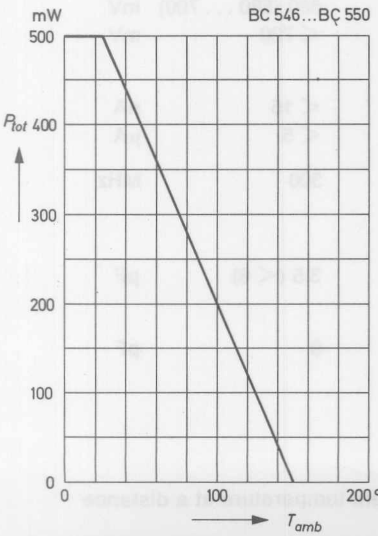
| $h$-Parameters at $V_{CE} = 5$ V, $I_C = 2$ mA, $f = 1$ kHz | | Current Gain Group A | B | C | |
|---|---|---|---|---|---|
| Current gain | $h_{fe}$ | 220 (125...260) | 330 (240...500) | 600 (450...900) | |
| Input impedance | $h_{ie}$ | 2.7 (1.6...4.5) | 4.5 (3.2...8.5) | 8.7 (6...15) | kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 30 (< 60) | 60 (< 110) | µmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |
| DC current gain | | | | | |
| at $V_{CE} = 5$ V, $I_C = 10$ µA | $h_{FE}$ | 90 | 150 | 270 | |
| at $V_{CE} = 5$ V, $I_C = 2$ mA | $h_{FE}$ | 180 | 290 | 500 | |
| at $V_{CE} = 5$ V, $I_C = 100$ mA | $h_{FE}$ | 120 | 200 | 400 | |

| | | | |
|---|---|---|---|
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 250 [1]) | °C/W |
| Collector saturation voltage | | | |
| at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{CE\,sat}$ | 90 (< 250) | mV |
| at $I_C = 100$ mA, $I_B = 5$ mA | $V_{CE\,sat}$ | 200 (< 600) | mV |
| Base saturation voltage | | | |
| at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{BE\,sat}$ | 700 | mV |
| at $I_C = 100$ mA, $I_B = 5$ mA | $V_{BE\,sat}$ | 900 | mV |
| Base emitter voltage | | | |
| at $V_{CE} = 5$ V, $I_C = 2$ mA | $V_{BE}$ | 660 (580 . . . 700) | mV |
| at $V_{CE} = 5$ V, $I_C = 10$ mA | $V_{BE}$ | < 720 | mV |
| Collector cutoff current | | | |
| at $V_{CB} = 30$ V | $I_{CB0}$ | < 15 | nA |
| at $V_{CB} = 30$ V, $T_j = 150\ °C$ | $I_{CB0}$ | < 5 | µA |
| Gain bandwidth product at $V_{CE} = 5$ V, $I_C = 10$ mA, $f = 100$ MHz | $f_T$ | 300 | MHz |
| Collector base capacitance at $V_{CB} = 10$ V, $f = 1$ MHz | $C_{CB0}$ | 3.5 (< 6) | pF |
| Emitter base capacitance at $V_{EB} = 0.5$ V, $f = 1$ MHz | $C_{EB0}$ | 9 | pF |

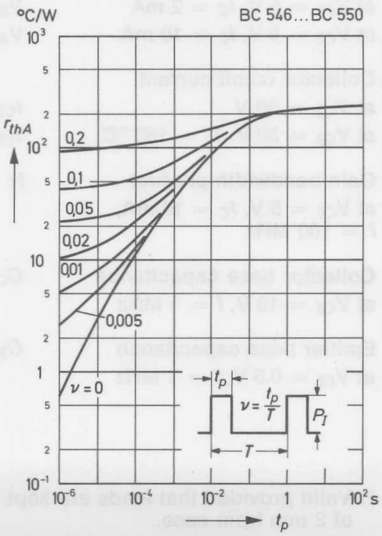
[1]) Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | BC 546<br>BC 547<br>BC 548 | BC 549<br>BC 550 | |
|---|---|---|---|---|
| Noise figure<br>at $V_{CE} = 5$ V, $I_C = 200$ µA,<br>$R_G = 2$ kΩ, $f = 1$ kHz, $\Delta f = 200$ Hz | $F$ | 2 (< 10) | 1.2 (< 4) | dB |
| | | BC 549 | BC 550 | |
| Noise figure<br>at $V_{CE} = 5$ V, $I_C = 200$ µA,<br>$R_G = 2$ kΩ, $f = 30 \ldots 15\,000$ Hz | $F$ | 1.4 (< 4) | 1.4 (< 3) | dB |
| Equivalent noise EMF<br>at $V_{CE} = 5$ V, $I_C = 200$ µA,<br>$R_G = 2$ kΩ, $f = 10 \ldots 50$ Hz | $v_r$ | – | < 0.135 | µV |

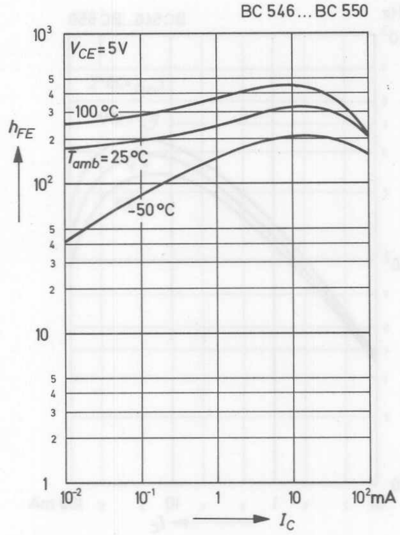
**Admissible power dissipation versus temperature**
(see note page 67)



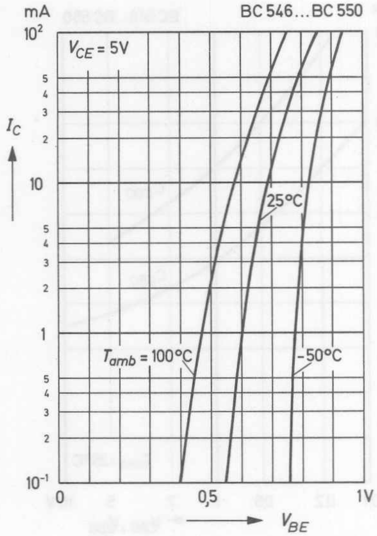

**Pulse thermal resistance versus pulse duration**
(see note page 67)



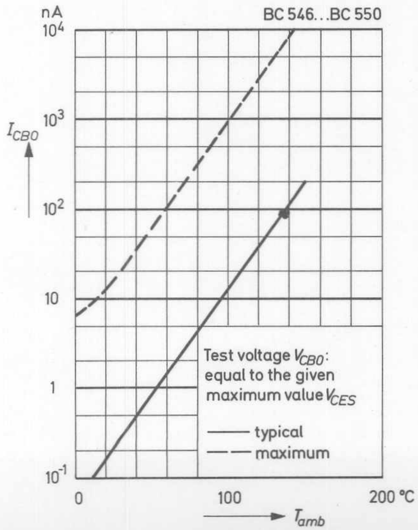
**DC current gain versus collector current**



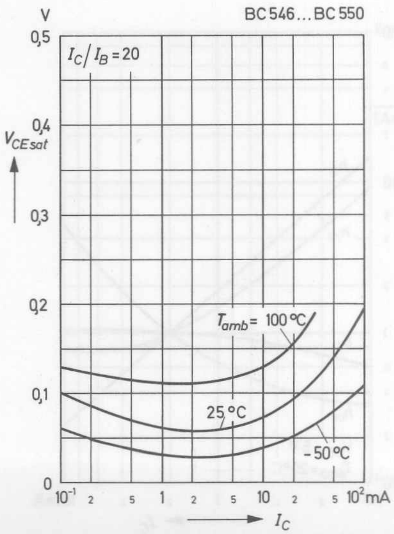

**Collector current versus base emitter voltage**



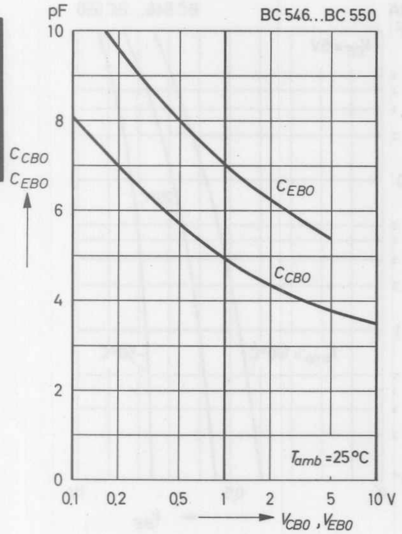

**Collector cutoff current versus ambient temperature**



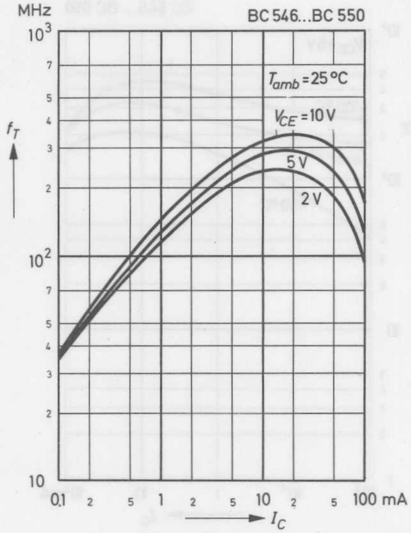

**Collector saturation voltage versus collector current**



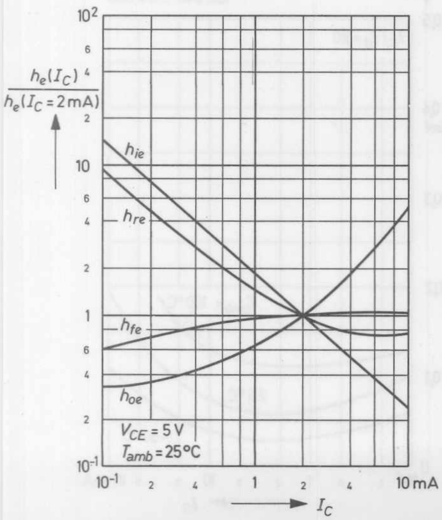
**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



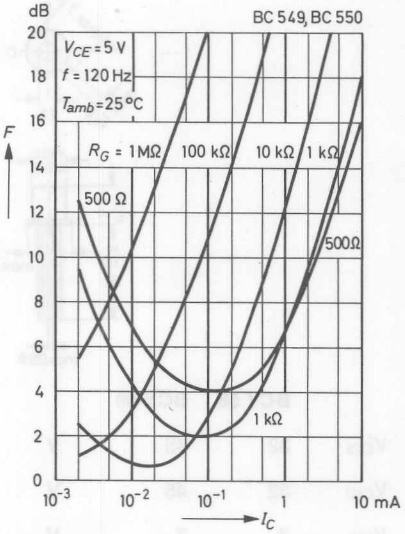

**Gain bandwidth product versus collector current**



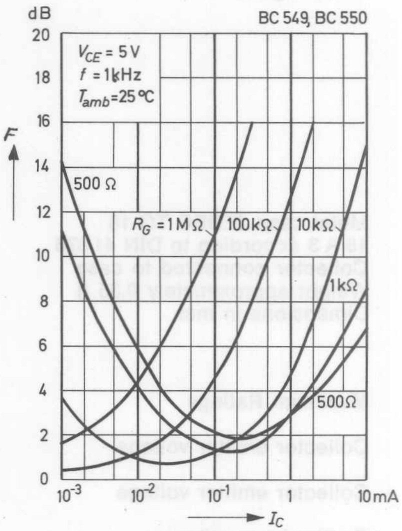

**Relative *h*-parameters versus collector current**



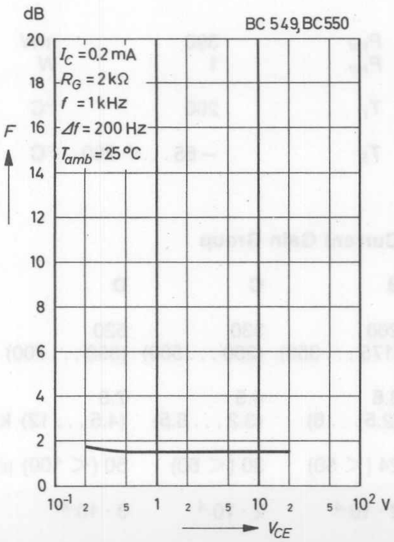
**Noise figure
versus collector current**




**Noise figure
versus collector current**



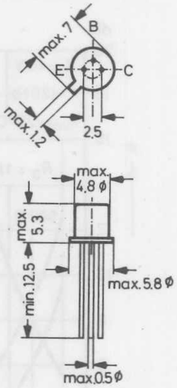

**Noise figure
versus collector emitter voltage**



# BCY 58, BCY 59

**NPN Silicon Epitaxial Planar Transistors**
for switching and amplifier applications
in commercial electronic design

The transistors are subdivided into four groups A, B, C and D according to their current gain.




**Metal case JEDEC TO-18**
**18 A 3 according to DIN 41 876**
**Collector connected to case**
**Weight approximately 0.35 g**
**Dimensions in mm**

| **Maximum Ratings** | | **BCY 58** | **BCY 59** | |
|---|---|---|---|---|
| Collector emitter voltage | $V_{CES}$ | 32 | 45 | V |
| Collector emitter voltage | $V_{CEO}$ | 32 | 45 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | 7 | V |
| Collector current | $I_C$ | | 200 | mA |
| Base current | $I_B$ | | 50 | mA |
| Power dissipation<br>at $T_{amb} = 25\ °C$<br>at $T_C\ = 45\ °C$ | <br>$P_{tot}$<br>$P_{tot}$ | | <br>390<br>1 | <br>mW<br>W |
| Junction temperature | $T_j$ | | 200 | °C |
| Storage temperature range | $T_S$ | | −65 . . . + 200 | °C |

**Characteristics** at $T_{amb} = 25\ °C$

| | | | **Current Gain Group** | | |
|---|---|---|---|---|---|
| $h$-Parameter at $V_{CE} = 5$ V,<br>$I_C = 2$ mA, $f = 1$ kHz | | **A** | **B** | **C** | **D** |
| Small signal current gain | $h_{fe}$ | 200<br>(125 . . . 250) | 260<br>(175 . . . 350) | 330<br>(250 . . . 500) | 520<br>(350 . . . 700) |
| Input impedance | $h_{ie}$ | 2.7<br>(1.6 . . . 4.5) | 3.6<br>(2.5 . . . 6) | 4.5<br>(3.2 . . . 8.5) | 7.5<br>(4.5 . . . 12) kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 24 (< 50) | 30 (< 60) | 50 (< 100) µmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ |

| | | Current Gain Group | | | | |
|---|---|---|---|---|---|---|
| | | A | B | C | D | |
| DC current gain | | | | | | |
| at $V_{CE} = 5$ V, $I_C = 10\ \mu A$ | $h_{FE}$ | 78 | 145 (> 20) | 220 (> 40) | 300 (> 100) | |
| at $V_{CE} = 5$ V, $I_C = 2$ mA | $h_{FE}$ | 170 (120 . . . 220) | 250 (180 . . . 310) | 350 (250 . . . 460) | 500 (380 . . . 630) | |
| at $V_{CE} = 1$ V, $I_C = 10$ mA | $h_{FE}$ | 190 (> 80) | 260 (120 . . . 400) | 380 (160 . . . 630) | 550 (240 . . 1000) | |
| at $V_{CE} = 1$ V, $I_C = 100$ mA | $h_{FE}$ | > 40 | > 45 | > 60 | > 60 | |

| | | | |
|---|---|---|---|
| Base emitter voltage | | | |
| at $V_{CE} = 5$ V, $I_C = 10\ \mu A$ | $V_{BE}$ | 0.5 | V |
| at $V_{CE} = 5$ V, $I_C = 2$ mA | $V_{BE}$ | 0.62 (0.55 . . . 0.7) | V |
| at $V_{CE} = 1$ V, $I_C = 10$ mA | $V_{BE}$ | 0.7 | V |
| at $V_{CE} = 1$ V, $I_C = 100$ mA | $V_{BE}$ | 0.76 | V |
| Collector saturation voltage | | | |
| at $I_C = 10$ mA, $I_B = 0.25$ mA | $V_{CE\,sat}$ | 0.12 (0.05 . . . 0.35) | V |
| at $I_C = 100$ mA, $I_B = 2.5$ mA | $V_{CE\,sat}$ | 0.3 (0.15 . . . 0.7) | V |
| Base saturation voltage | | | |
| at $I_C = 10$ mA, $I_B = 0.25$ mA | $V_{BE\,sat}$ | 0.7 (0.6 . . . 0.85) | V |
| at $I_C = 100$ mA, $I_B = 2.5$ mA | $V_{BE\,sat}$ | 0.9 (0.75 . . . 1.2) | V |

| | | BCY 58 | BCY 59 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $V_{CE} = 32$ V | $I_{CES}$ | 0.2 (< 10) | – | nA |
| at $V_{CE} = 45$ V | $I_{CES}$ | – | 0.2 (< 10) | nA |
| at $V_{CE} = 32$ V, $T_{amb} = 150$ °C | $I_{CES}$ | 0.2 (< 10) | – | μA |
| at $V_{CE} = 45$ V, $T_{amb} = 150$ °C | $I_{CES}$ | – | 0.2 (< 10) | μA |
| at $V_{CE} = 32$ V, $V_{BE} = 0.2$ V, $T_{amb} = 100$ °C | $I_{CEV}$ | < 20 | – | μA |
| at $V_{CE} = 45$ V, $V_{BE} = 0.2$ V, $T_{amb} = 100$ °C | $I_{CEV}$ | – | < 20 | μA |
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EBO}$ | < 10 | < 10 | nA |
| Collector emitter breakdown voltage at $I_C = 2$ mA | $V_{(BR)CEO}$ | > 32 | > 45 | V |
| Emitter base breakdown voltage at $I_E = 1\ \mu A$ | $V_{(BR)EBO}$ | > 7 | > 7 | V |
| Gain bandwidth product at $V_{CE} = 5$ V, $I_C = 10$ mA, $f = 100$ MHz | $f_T$ | 250 (> 125) | | MHz |
| Collector base capacitance at $V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | 3.5 (< 6) | | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V, $f = 1$ MHz | $C_{EBO}$ | 8 (< 15) | | pF |

| | | | |
|---|---|---|---|
| Noise figure<br>at $V_{CE} = 5$ V, $I_C = 0.2$ mA,<br>$R_G = 2$ kΩ, $f = 1$ kHz, $\Delta f = 200$ Hz | $F$ | 2 (< 6) | dB |

Thermal resistance

| | | | |
|---|---|---|---|
| Junction to ambient air | $R_{th\,A}$ | < 450 | °C/W |
| Junction to case | $R_{th\,C}$ | < 150 | °C/W |

**Switching Times**

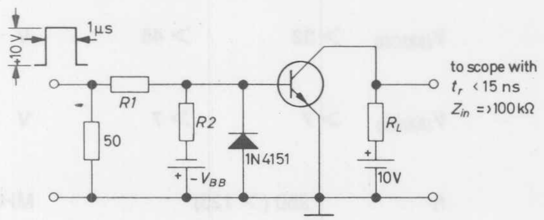
Test conditions:
$I_C : I_{B1} : -I_{B2} \sim 10:1:1$ mA, $R_1 = 5$ kΩ, $R_2 = 5$ kΩ, $R_L = 990$ Ω, $-V_{BB} = 3.6$ V

| | | | |
|---|---|---|---|
| Delay time | $t_d$ | 35 | ns |
| Rise time | $t_r$ | 50 | ns |
| Turn-on time | $t_{on}$ | 85 (< 150) | ns |
| Storage time | $t_s$ | 400 | ns |
| Fall time | $t_f$ | 80 | ns |
| Turn-off time | $t_{off}$ | 480 (< 800) | ns |

Test conditions:
$I_C : I_{B1} : -I_{B2} \sim 100:10:10$ mA, $R_1 = 500$ Ω, $R_2 = 700$ Ω, $R_L = 98$ Ω, $-V_{BB} = 5$ V

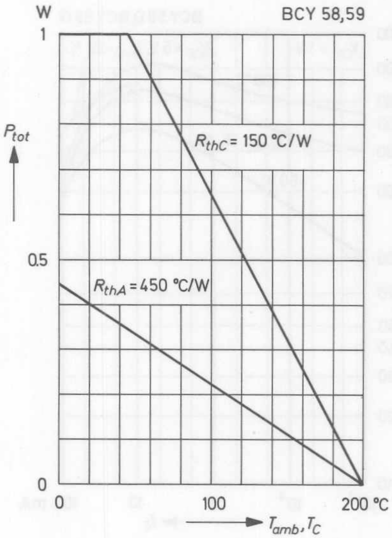
| | | | |
|---|---|---|---|
| Delay time | $t_d$ | 5 | ns |
| Rise time | $t_r$ | 50 | ns |
| Turn-on time | $t_{on}$ | 55 (< 150) | ns |
| Storage time | $t_s$ | 250 | ns |
| Fall time | $t_f$ | 200 | ns |
| Turn-off time | $t_{off}$ | 450 (< 800) | ns |

**Test Circuit for Switching Times**

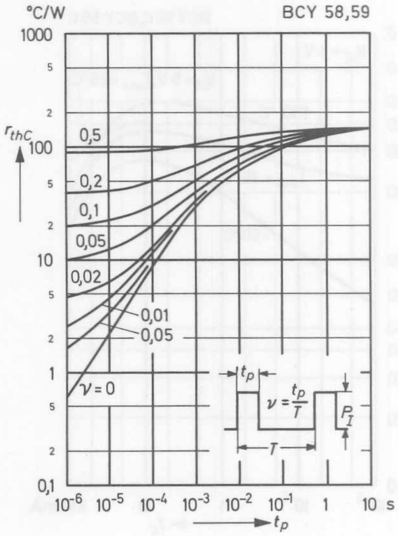



Rise time of input voltage 5 ns, pulse duty factor < 1 %,
generator impedance 50 Ω

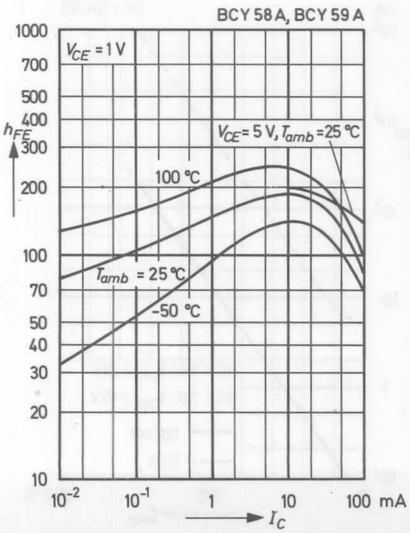
**Admissible power dissipation versus temperature**



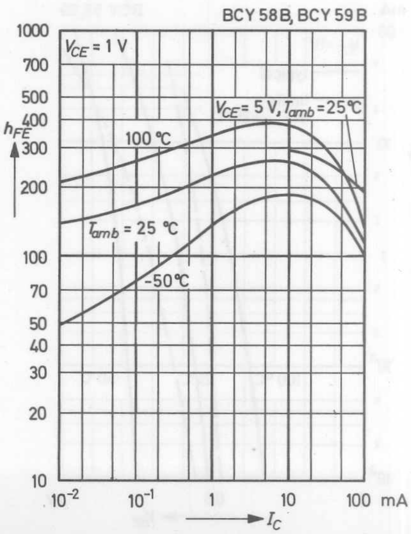

**Pulse thermal resistance versus pulse duration**



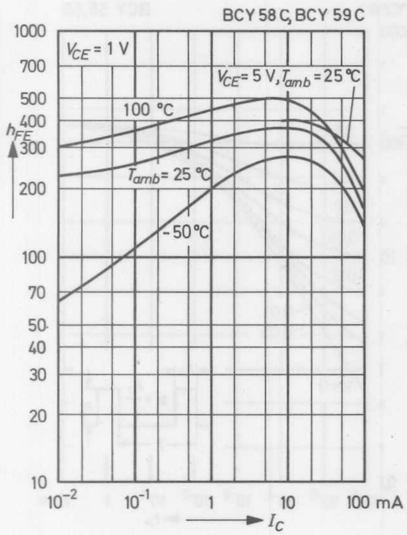

**DC current gain versus collector current**



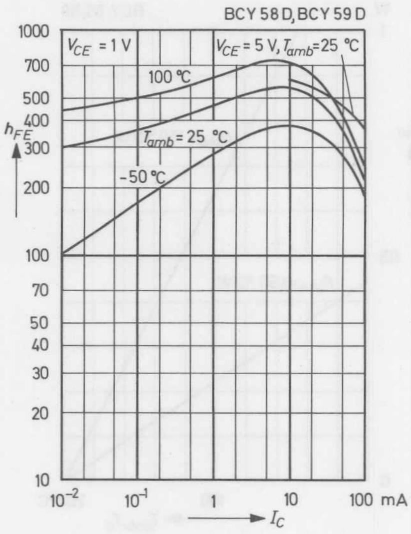

**DC current gain versus collector current**



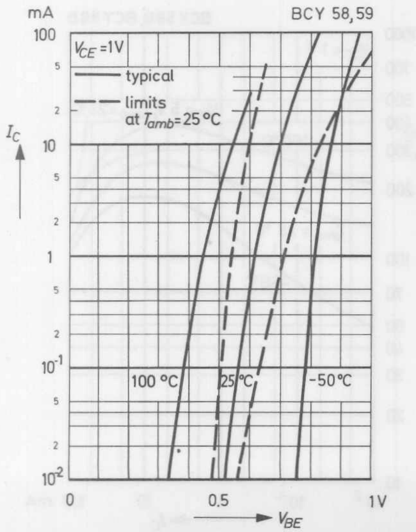
**DC current gain versus collector current**



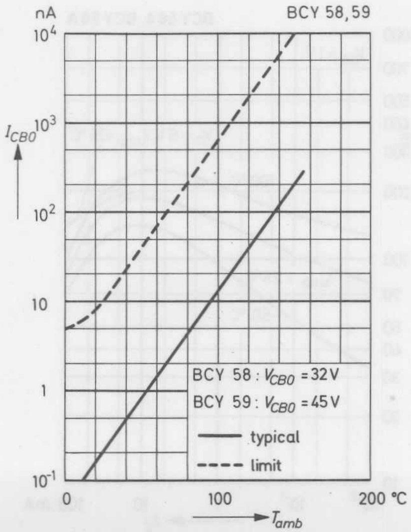

**DC current gain versus collector current**



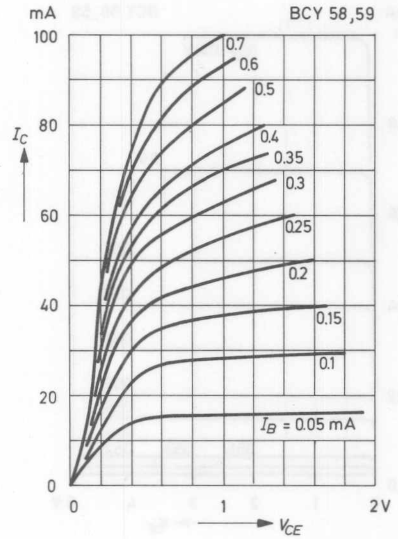

**Collector current versus base emitter voltage**



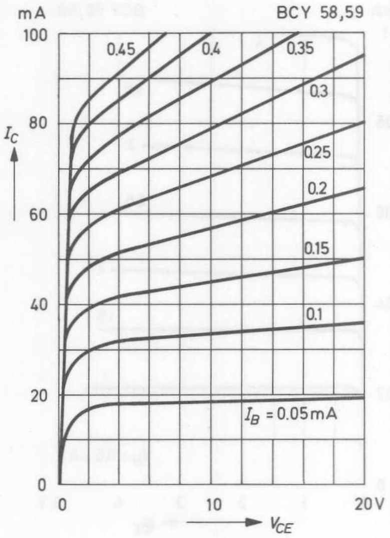

**Collector cutoff current versus ambient temperature**



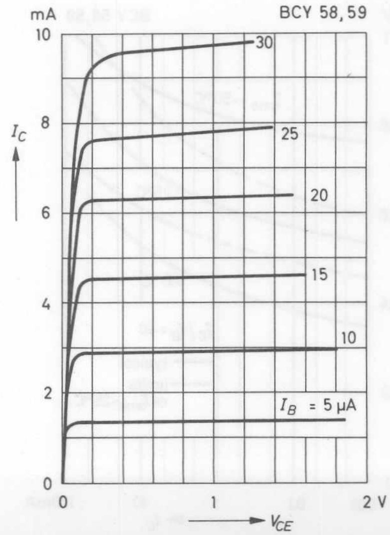
**Common emitter collector characteristics**



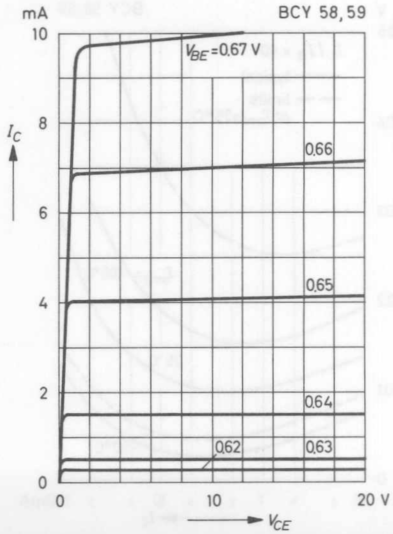

**Common emitter collector characteristics**



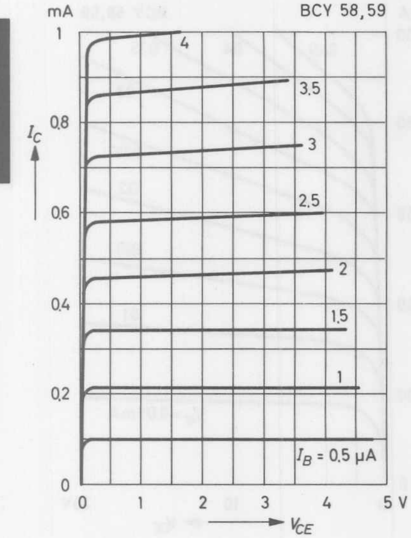

**Common emitter collector characteristics**



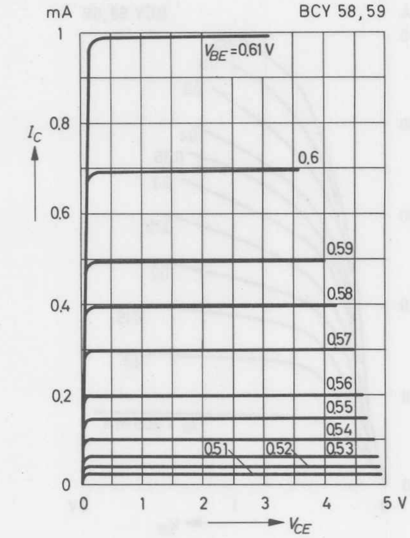

**Common emitter collector characteristics**



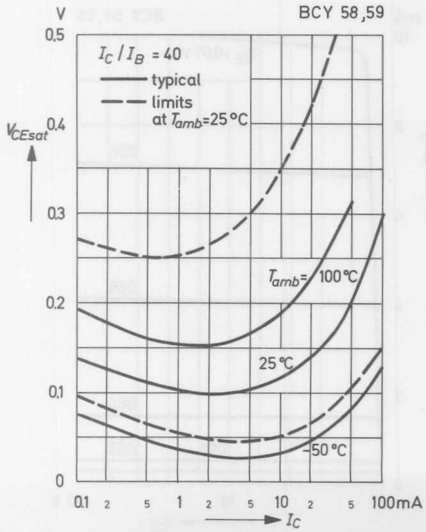
**Common emitter collector characteristics**



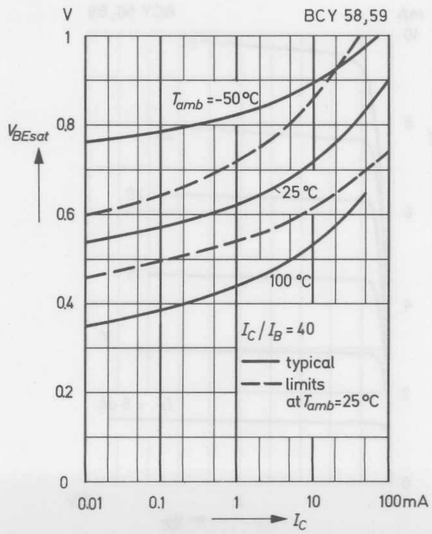

**Common emitter collector characteristics**



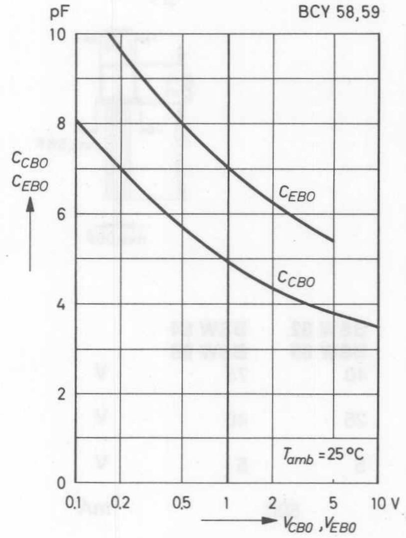

**Collector saturation voltage versus collector current**



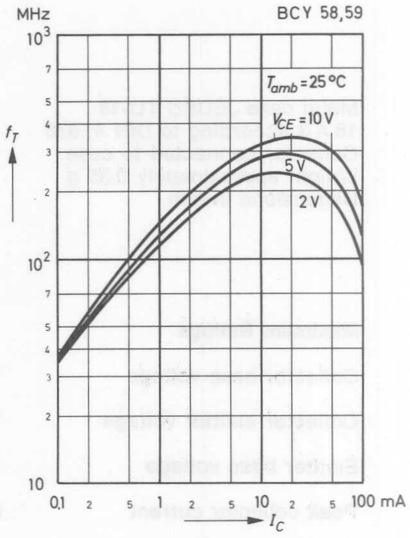

**Base saturation voltage versus collector current**



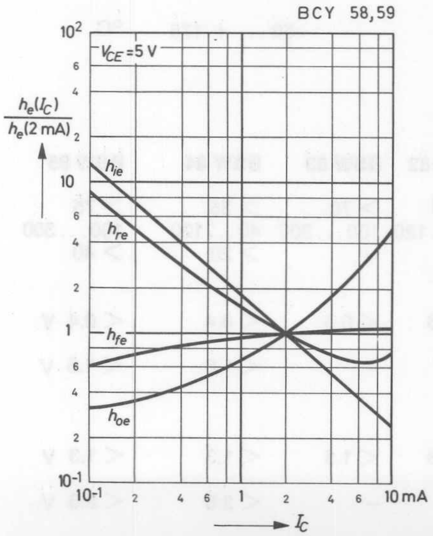
**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



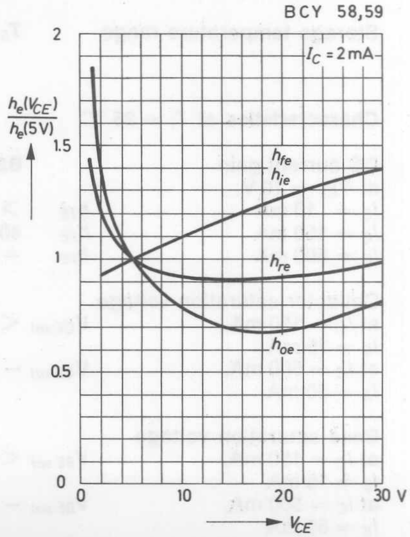

**Gain bandwidth product versus collector current**




**Relative *h*-parameters versus collector current**

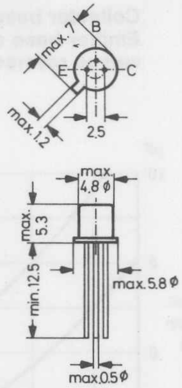



**Relative *h*-parameters versus collector emitter voltage**



# BSW 82, BSW 83, BSW 84, BSW 85

**NPN Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

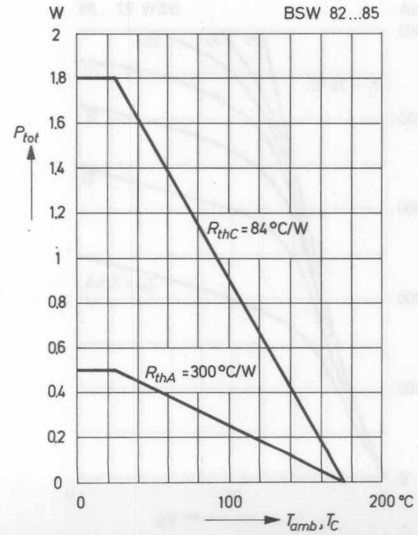
| **Maximum Ratings** | | **BSW 82** **BSW 83** | **BSW 84** **BSW 85** | |
|---|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | 75 | V |
| Collector emitter voltage | $V_{CEO}$ | 25 | 40 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | 5 | V |
| Peak collector current | $I_{CM}$ | 500 | | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 500 | | mW |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1.8 | | W |
| Junction temperature | $T_j$ | 175 | | °C |
| Storage temperature range | $T_S$ | −50 ... + 175 | | °C |

**Characteristics** at $T_j = 25\ °C$

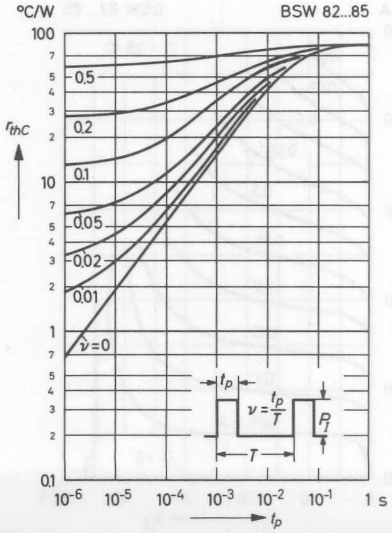
| | | **BSW 82** | **BSW 83** | **BSW 84** | **BSW 85** | |
|---|---|---|---|---|---|---|
| DC current gain at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | $> 30$ | $> 70$ | $> 35$ | $> 75$ | |
| $I_C = 150$ mA | $h_{FE}$ | 40 ... 120 | 100 ... 300 | 40 ... 120 | 100 ... 300 | |
| $I_C = 500$ mA | $h_{FE}$ | – | – | $> 20$ | $> 40$ | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | $< 0.6$ | $< 0.6$ | $< 0.4$ | $< 0.4$ | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | – | – | $< 1.6$ | $< 1.6$ | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | $< 1.3$ | $< 1.3$ | $< 1.3$ | $< 1.3$ | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{BE\,sat}$ | – | – | $< 2.6$ | $< 2.6$ | V |

| | | BSW 82 | BSW 83 | BSW 84 | BSW 85 | |
|---|---|---|---|---|---|---|
| Collector cutoff current | | | | | | |
| at $V_{CB} = 30$ V | $I_{CB0}$ | < 100 | < 100 | – | – | nA |
| at $V_{CB} = 50$ V | $I_{CB0}$ | – | – | < 10 | < 10 | nA |
| at $V_{CB} = 30$ V, $T_j = 125$ °C | $I_{CB0}$ | < 100 | < 100 | – | – | µA |
| at $V_{CB} = 50$ V, $T_j = 125$ °C | $I_{CB0}$ | – | – | < 10 | < 10 | µA |
| Emitter cutoff current at $V_{EB} = 3$ V | $I_{EB0}$ | < 100 | | | | nA |
| Gain bandwidth product at $V_{CE} = 20$ V, $I_C = 20$ mA, $f = 100$ MHz | $f_T$ | > 200 | | | | MHz |
| Collector base capacitance at $V_{CB0} = 10$ V, $f = 100$ kHz | $C_{CB0}$ | < 8 | | | | pF |
| Thermal resistance | | | | | | |
| Junction to ambient air | $R_{thA}$ | < 300 | | | | °C/W |
| Junction to case | $R_{thC}$ | < 84 | | | | °C/W |

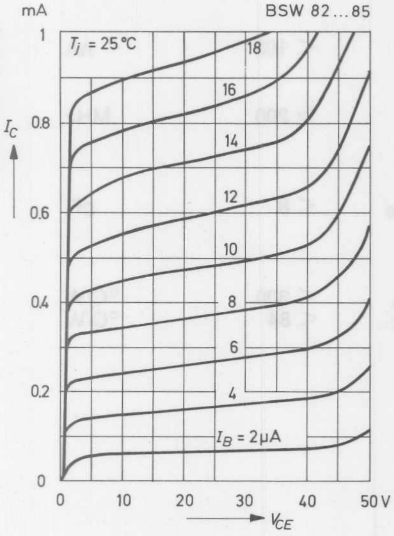
**Admissible power dissipation versus temperature**



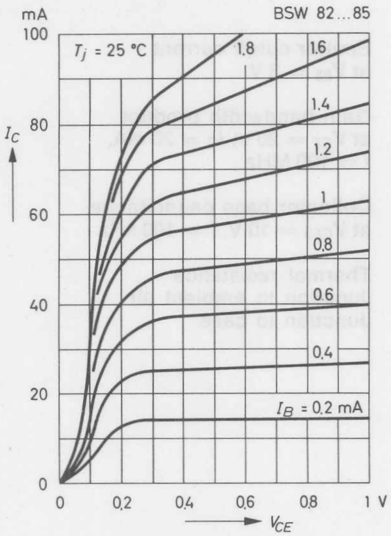

**Pulse thermal resistance versus pulse duration**



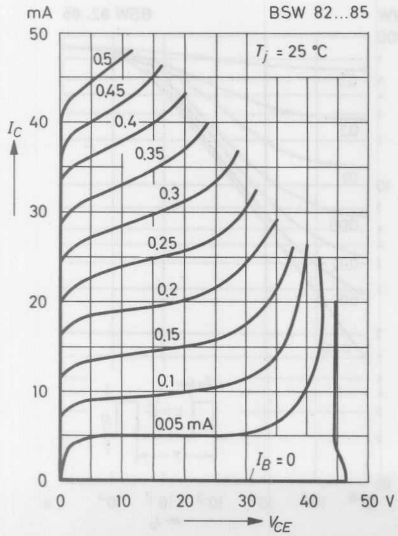
**Common emitter collector characteristics**



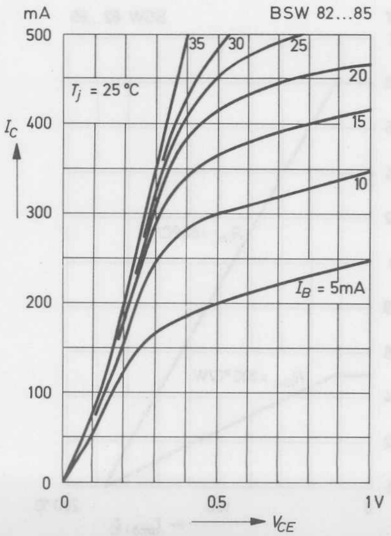

**Common emitter collector characteristics**



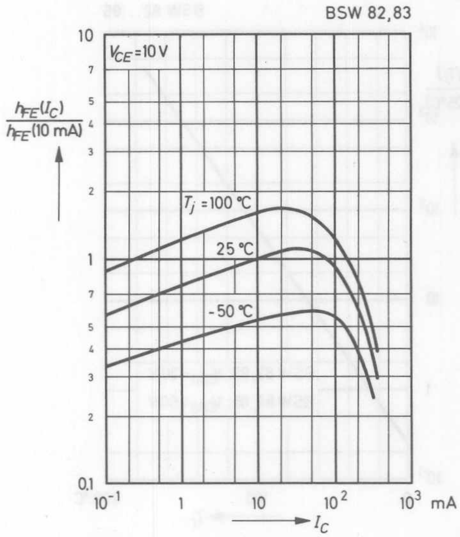

**Common emitter collector characteristics**



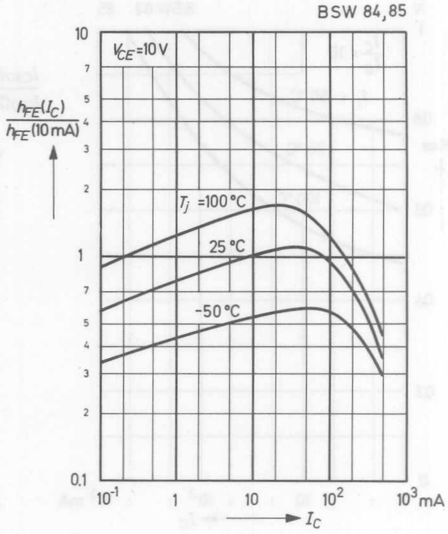

**Common emitter collector characteristics**



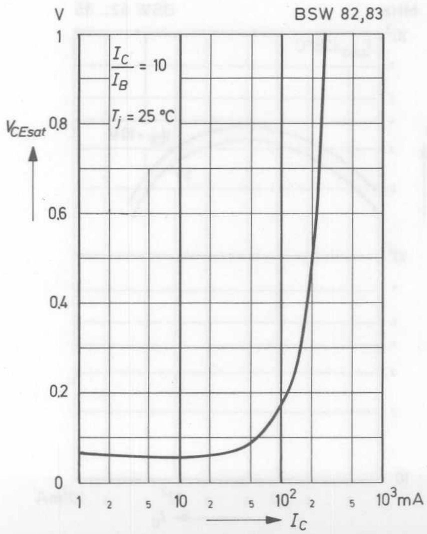
**Relative DC current gain versus collector current**



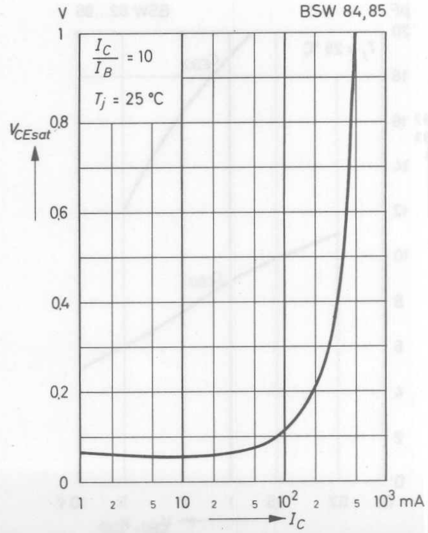

**Relative DC current gain versus collector current**



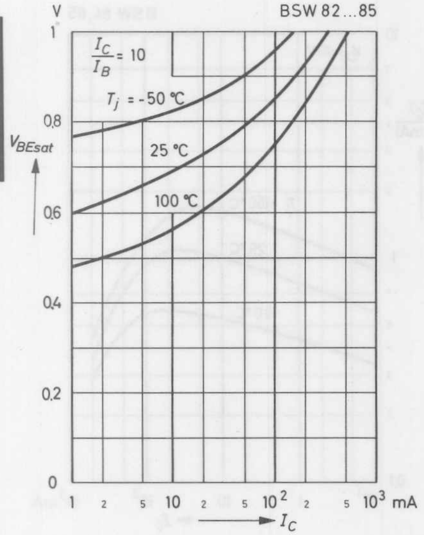

**Collector saturation voltage versus collector current**



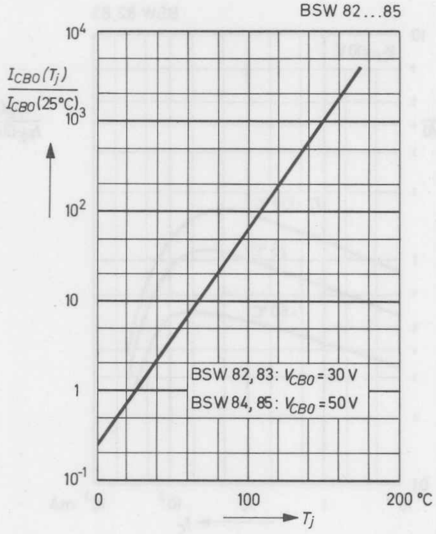

**Collector saturation voltage versus collector current**



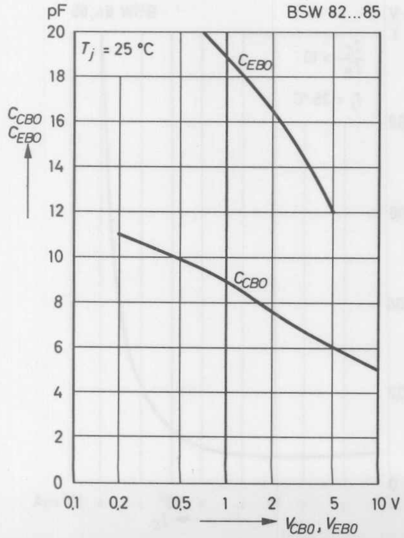
**Base saturation voltage versus collector current**



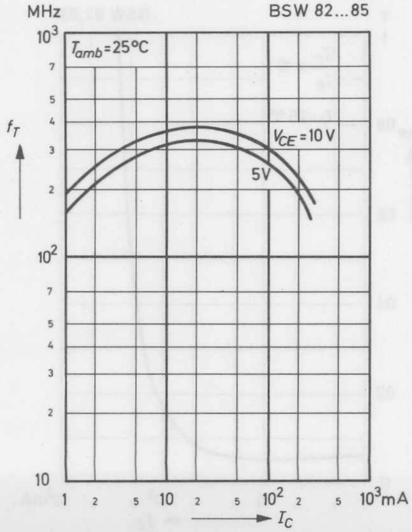

**Collector cutoff current versus junction temperature**




**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**

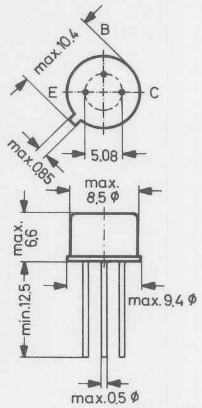



**Gain bandwidth product versus collector current**



# BSY 51 ≈ 2 N 697

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 60 | V |
| Collector emitter voltage | $V_{CE0}$ | 25 | V |
| Emitter base voltage | $V_{EB0}$ | 5 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Static Characteristics** at $T_j$ = 25 °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE}$ = 10 V, $I_C$ = 1 mA | $h_{FE}$ | 50 | |
| at $V_{CE}$ = 10 V, $I_C$ = 10 mA | $h_{FE}$ | 75 (> 30) | |
| at $V_{CE}$ = 10 V, $I_C$ = 150 mA | $h_{FE}$ | 40 . . . 120 | |
| at $V_{CE}$ = 10 V, $I_C$ = 500 mA | $h_{FE}$ | 15 | |
| Collector saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{CE\,sat}$ | 0.15 (< 0.8) | V |
| Base saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB}$ = 30 V | $I_{CB0}$ | 3 (< 100) | nA |
| at $V_{CB}$ = 30 V, $T_{amb}$ = 150 °C | $I_{CB0}$ | 4 (< 100) | µA |
| Emitter cutoff current at $V_{EB}$ = 3 V | $I_{EB0}$ | 1 (< 50) | nA |
| Collector base capacitance at $V_{CB0}$ = 10 V | $C_{CB0}$ | 7.5 (< 10) | pF |
| Emitter base capacitance at $V_{EB0}$ = 0.5 V | $C_{EB0}$ | 23 (< 33) | pF |

| | | | |
|---|---|---|---|
| Thermal resistance | | | |
| Junction to ambient air | $R_{th\,A}$ | $<220$ | °C/W |
| Junction to case | $R_{th\,C}$ | $<58$ | °C/W |

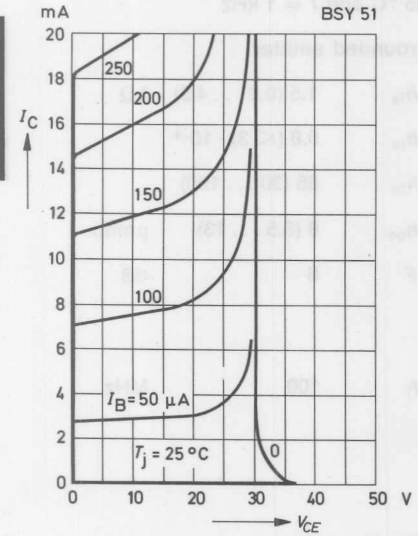
**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

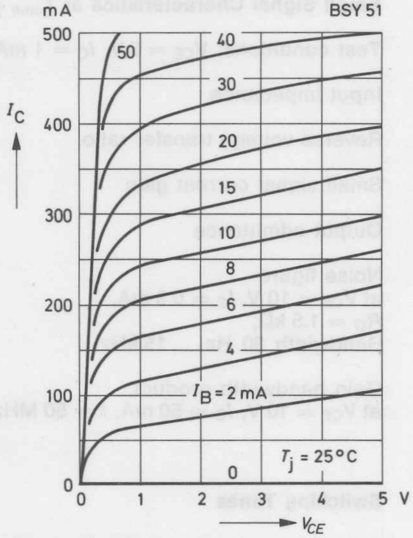
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 1.5 (0.8 . . . 4.5) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | $0.8\ (<3) \cdot 10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 55 (30 . . . 100) | |
| Output admittance | $h_{oe}$ | 8 (3.5 . . . 13) | µmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |

**Switching Times**

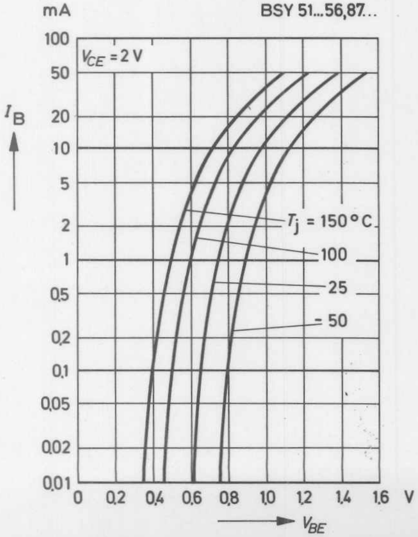
See diagrams and test circuits on the following pages.

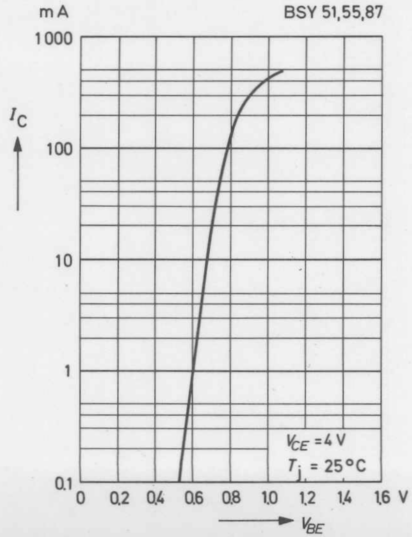


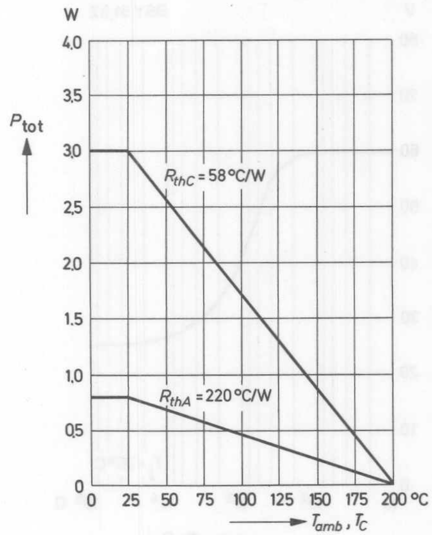

**Common emitter input characteristics**

**Collector current versus base emitter voltage**

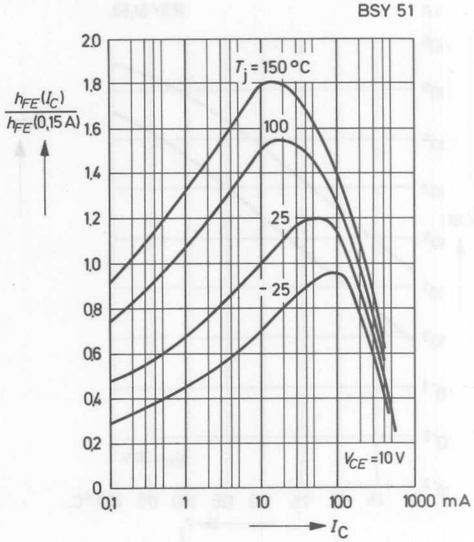


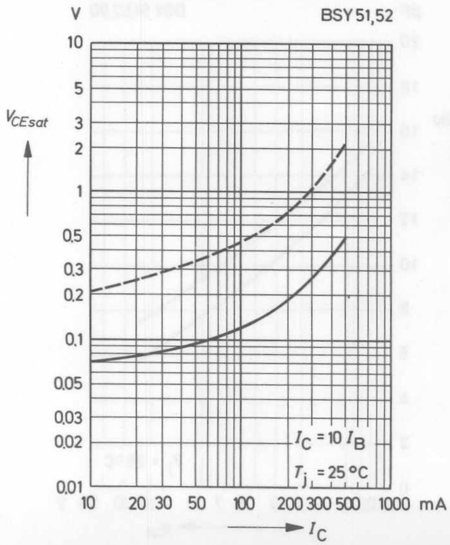
**Admissible power dissipation versus temperature**



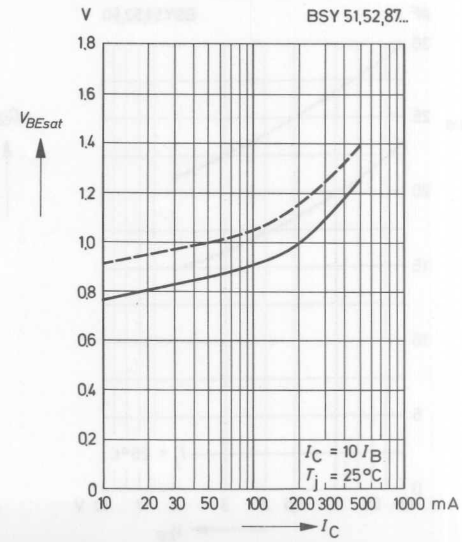

**Relative DC current gain versus collector current**




**Collector saturation voltage versus collector current**

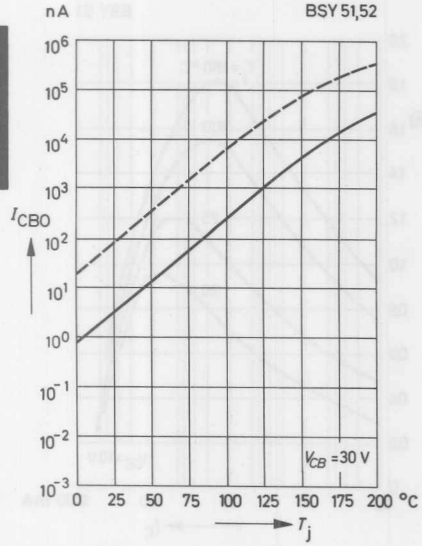



**Base saturation voltage versus collector current**

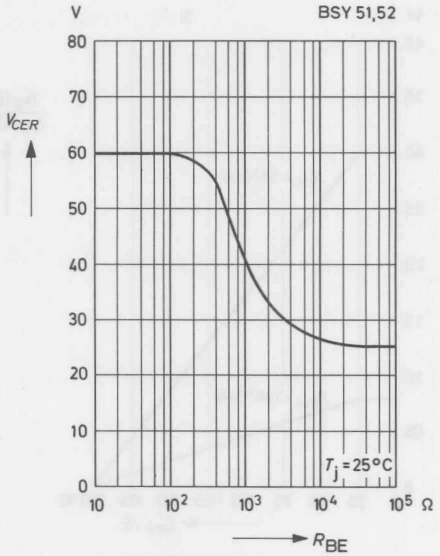



– – – – upper limit, valid for 95 % of a lot

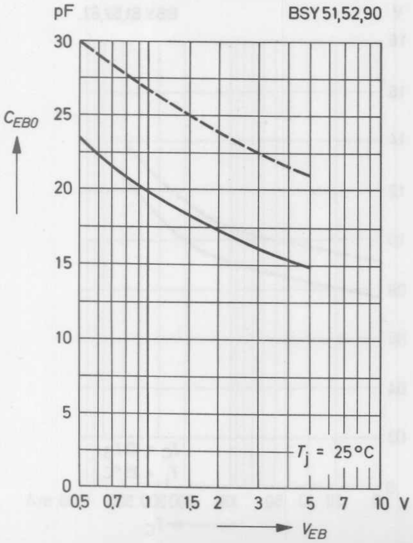
**Collector cutoff current versus junction temperature**



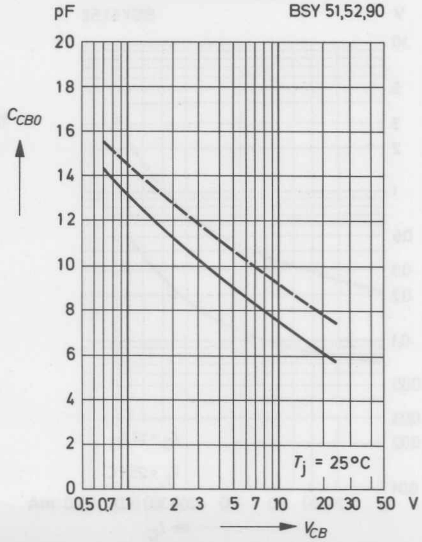

**Admissible collector emitter voltage versus base emitter resistance**




**Emitter base capacitance versus emitter base voltage**

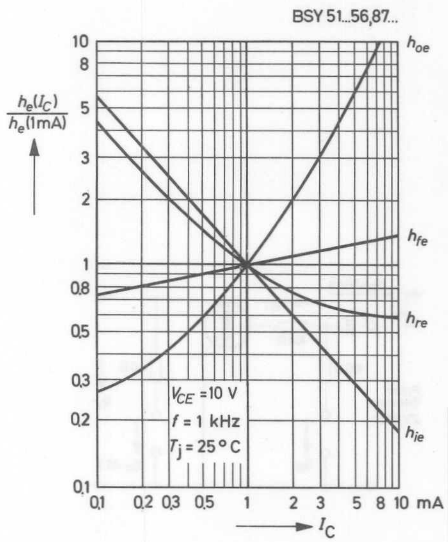



**Collector base capacitance versus collector base voltage**

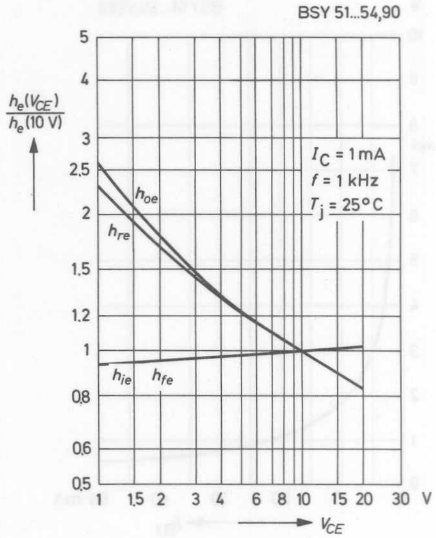



– – – – upper limit, valid for 95 % of a lot

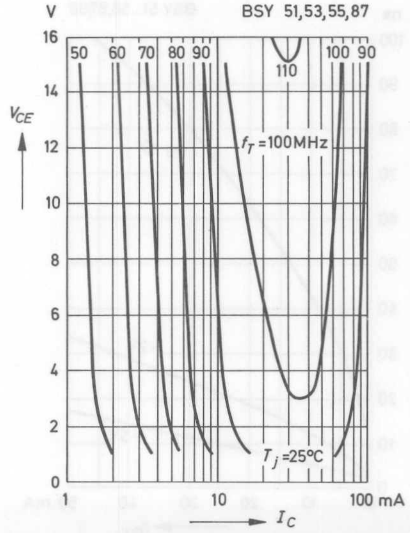
**Relative *h*-parameters versus collector current**



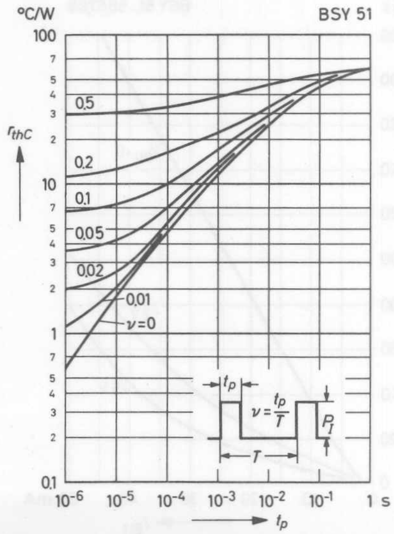

**Relative *h*-parameters versus collector emitter voltage**




**Contours of constant gain bandwidth product**

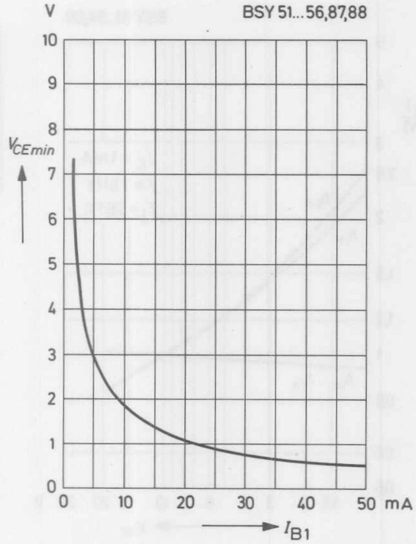



**Pulse thermal resistance versus pulse duration**

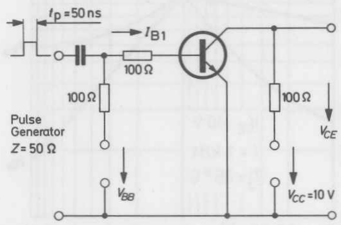


**Switching characteristics, $I_C = 100$ mA[1], $t_p = 50$ ns**

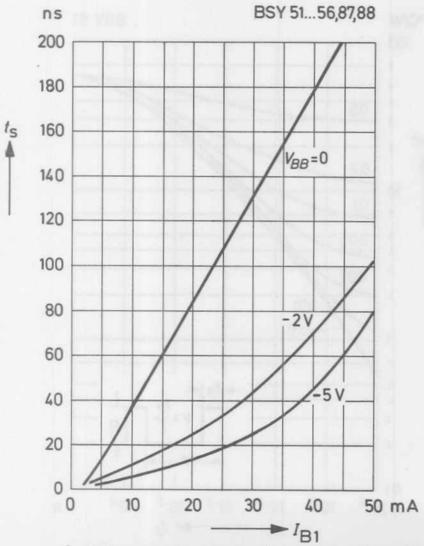
**Residual collector emitter voltage versus base current**



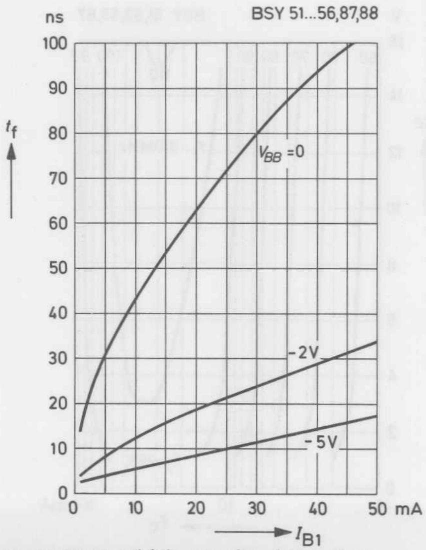

**Test circuit**




**Storage time versus base current**



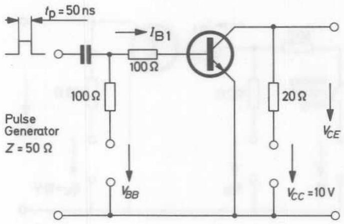

**Fall time versus base current**



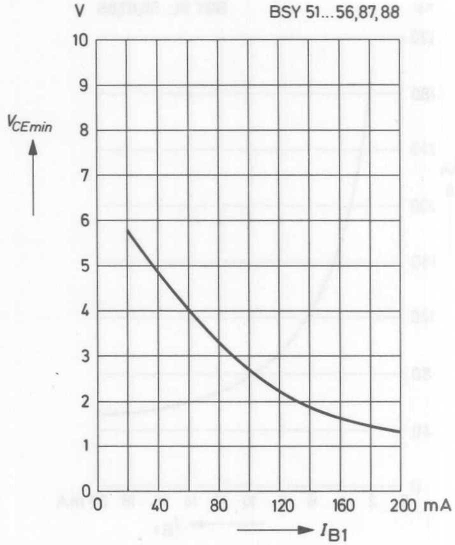

[1] 100 mA is that theoretical collector current which results from the supply voltage $V_{CC} = 10$ V and the operating resistor $R_{CC} = 100\ \Omega$.

**Switching characteristics, $I_C = 500$ mA[1], $t_p = 50$ ns**

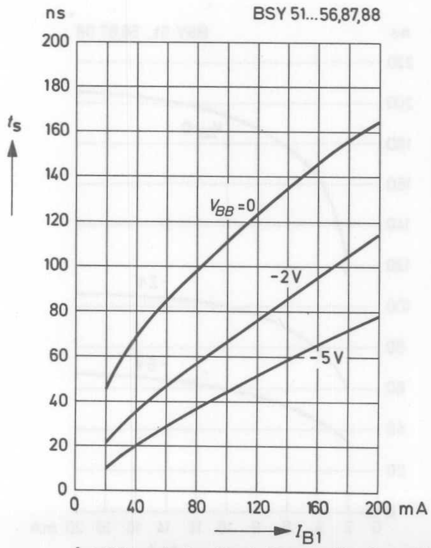
**Test circuit**



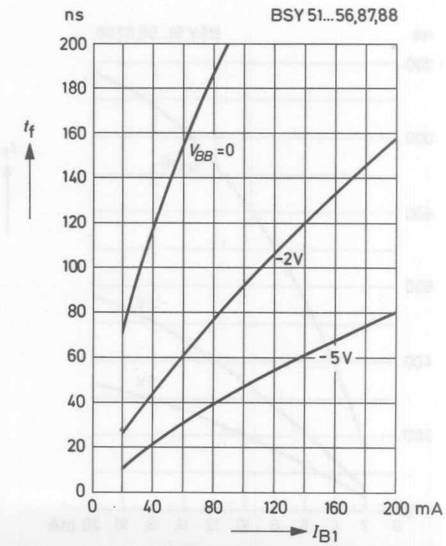

**Residual collector emitter voltage versus base current**




**Storage time versus base current**



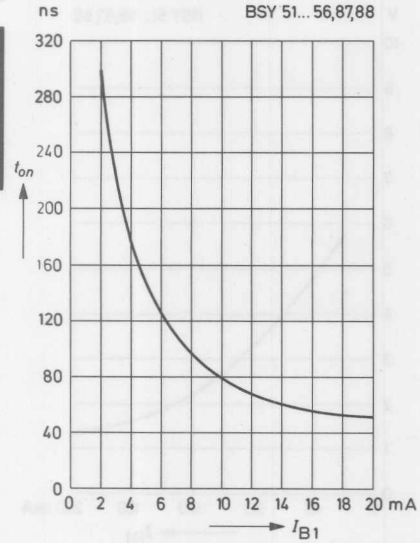

**Fall time versus base current**



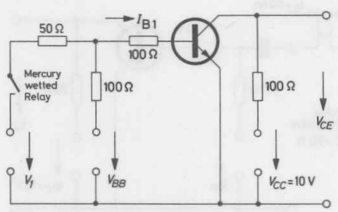

[1] 500 mA is that theoretical collector current which results from the supply voltage $V_{CC} = 10$ V and the operating resistor $R_{CC} = 20\ \Omega$.

## Switching characteristics, $I_C = 100$ mA, $t_p > 10$ µs

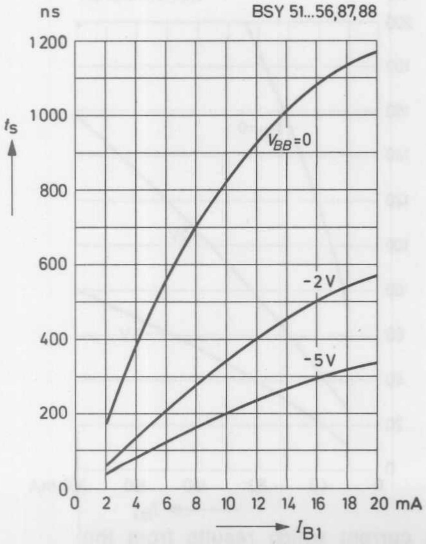
### Turn-on time versus base current



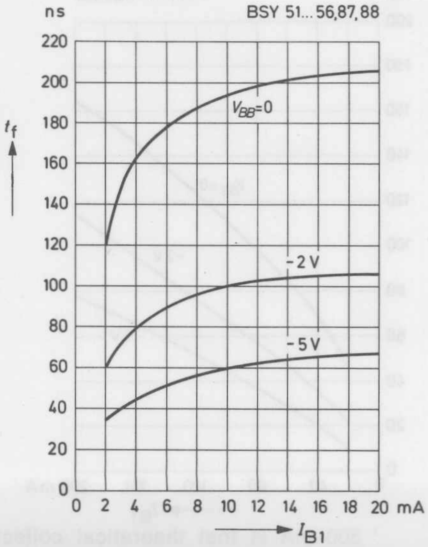

### Test circuit



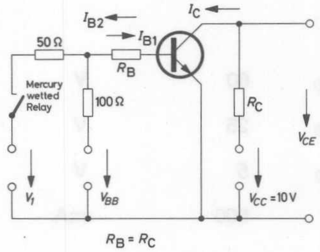

### Storage time versus base current



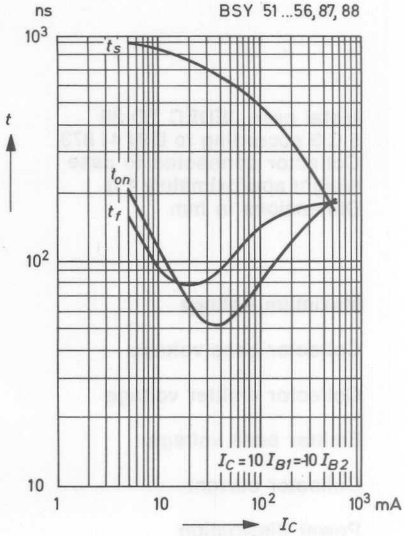

### Fall time versus base current



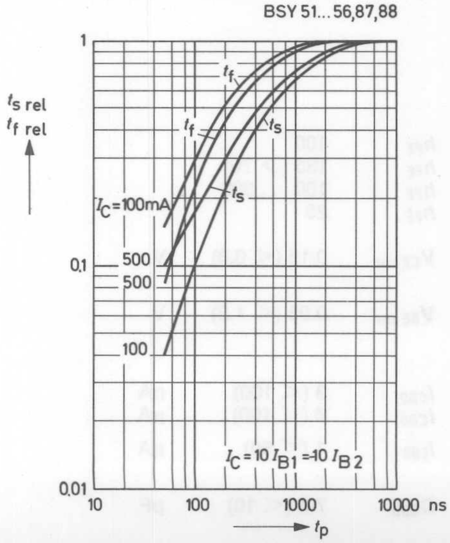
**Test circuit**
for graph on the right




**Switching characteristics versus collector current**
($t_p > 10\ \mu s$)

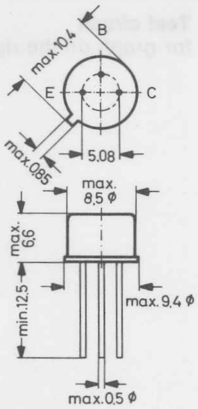



**Relative storage time and fall time versus pulse duration**



# BSY 52 ≈ 2 N 1420

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 60 | V |
| Collector emitter voltage | $V_{CEO}$ | 25 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Static Characteristics** at $T_j$ = 25 °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE}$ = 10 V, $I_C$ = 1 mA | $h_{FE}$ | 100 | |
| at $V_{CE}$ = 10 V, $I_C$ = 10 mA | $h_{FE}$ | 135 (> 70) | |
| at $V_{CE}$ = 10 V, $I_C$ = 150 mA | $h_{FE}$ | 100 . . . 300 | |
| at $V_{CE}$ = 10 V, $I_C$ = 500 mA | $h_{FE}$ | 25 | |
| Collector saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{CE\,sat}$ | 0.15 (< 0.8) | V |
| Base saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB}$ = 30 V | $I_{CBO}$ | 3 (< 100) | nA |
| at $V_{CB}$ = 30 V, $T_{amb}$ = 150 °C | $I_{CBO}$ | 4 (< 100) | µA |
| Emitter cutoff current at $V_{EB}$ = 3 V | $I_{EBO}$ | 1 (< 50) | nA |
| Collector base capacitance at $V_{CBO}$ = 5 V | $C_{CBO}$ | 7.5 (< 10) | pF |

| | | | |
|---|---|---|---|
| Emitter base capacitance<br>at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 23 (< 33) | pF |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{th\,A}$<br>$R_{th\,C}$ | <br>< 220<br>< 58 | <br>°C/W<br>°C/W |

**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

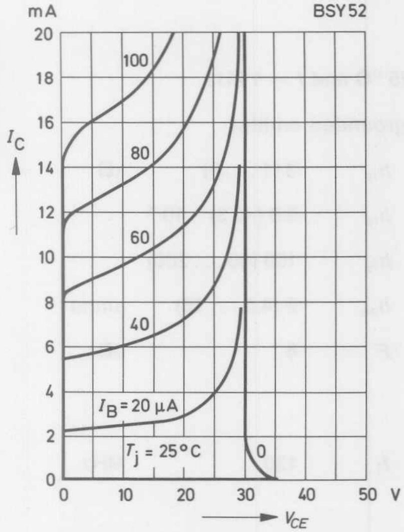
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 3 (1 . . . 8) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | 0.8 (< 3) · $10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 100 (50 . . . 200) | |
| Output admittance | $h_{oe}$ | 9 (4.5 . . . 15) | μmho |
| Noise figure<br>at $V_{CE} = 10$ V, $I_C = 0.3$ mA,<br>$R_G = 1.5$ kΩ<br>Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 130 | MHz |

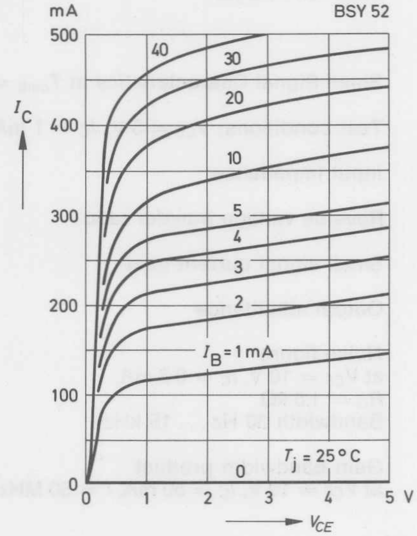
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

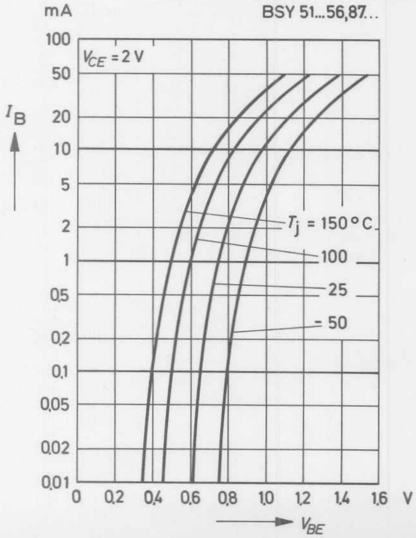
## Common emitter collector characteristics



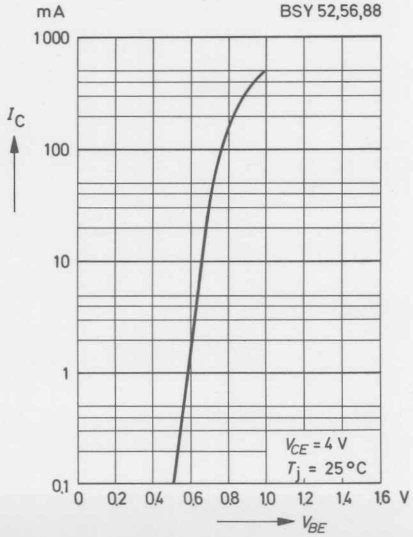

## Common emitter collector characteristics



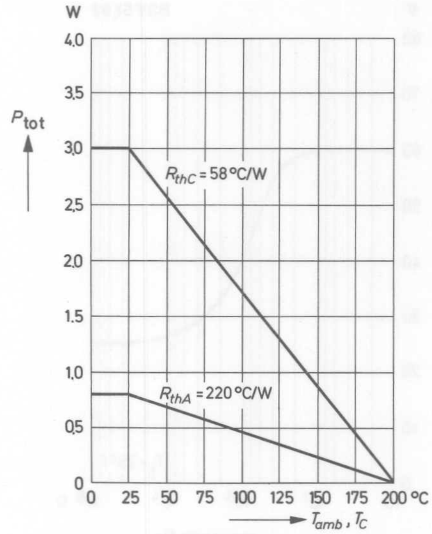

## Common emitter input characteristics



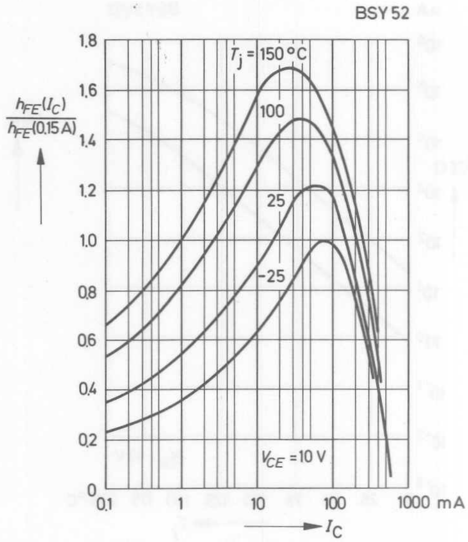

## Collector current versus base emitter voltage



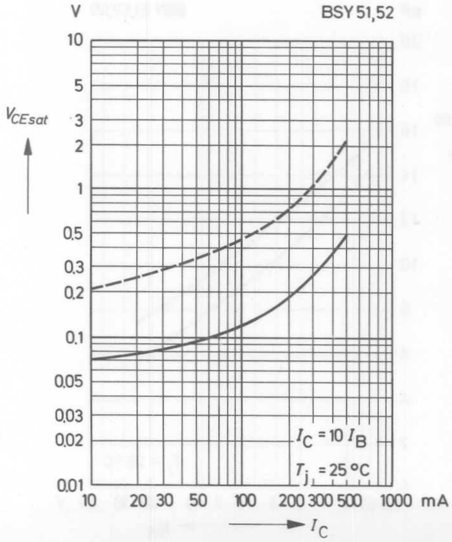
### Admissible power dissipation versus temperature



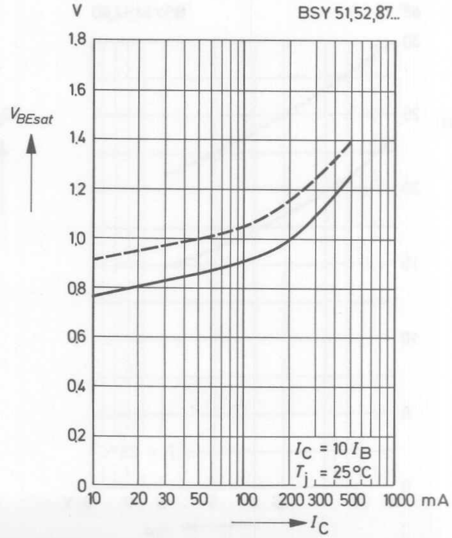

### Relative DC current gain versus collector current



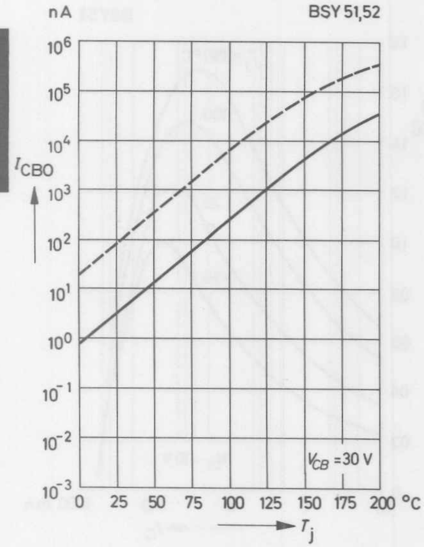

### Collector saturation voltage versus collector current

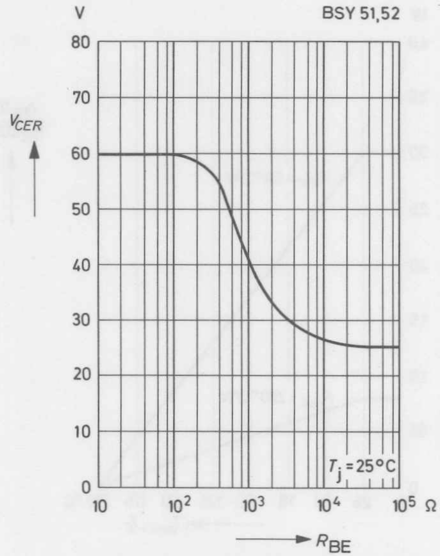



### Base saturation voltage versus collector current

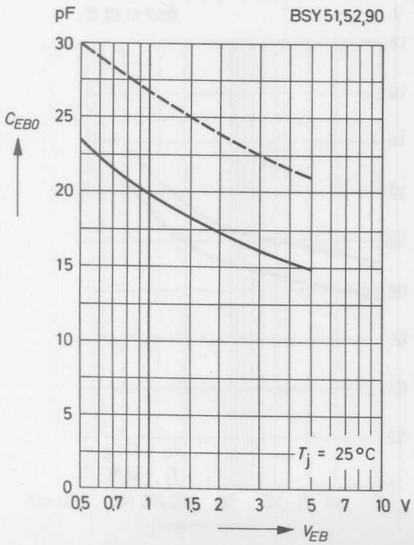



– – – – upper limit, valid for 95 % of a lot

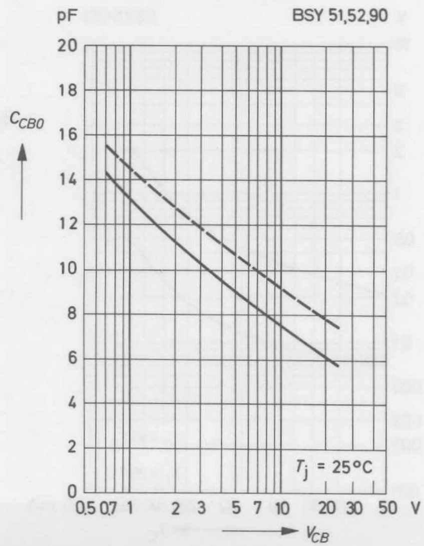



**Emitter base capacitance versus emitter base voltage**

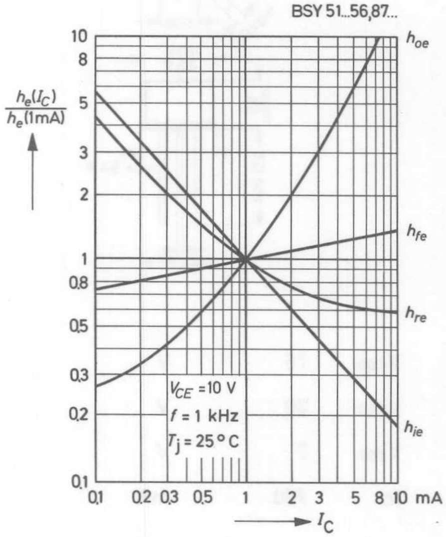



**Collector base capacitance versus collector base voltage**

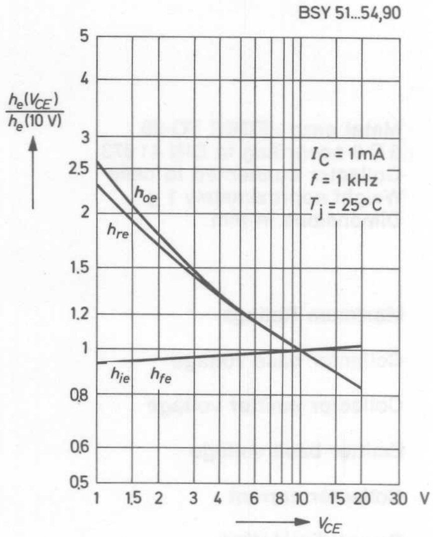



– – – – upper limit, valid for 95 % of a lot

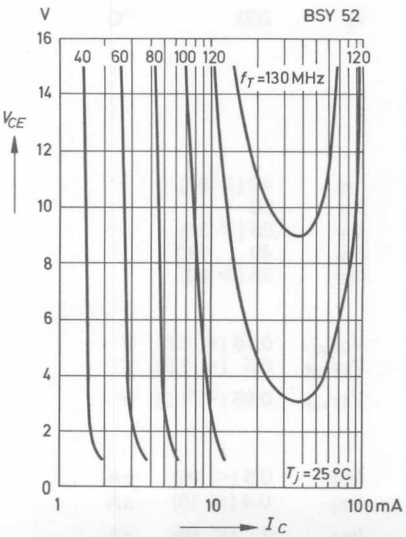
**Relative $h$-parameters versus collector current**



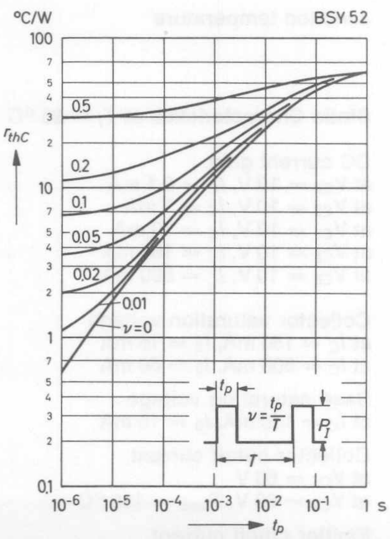

**Relative $h$-parameters versus collector emitter voltage**




**Contours of constant gain bandwidth product**

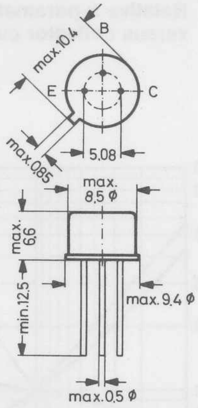



**Pulse thermal resistance versus pulse duration**



# BSY 53 ≈ 2 N 1613

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 75 | V |
| Collector emitter voltage | $V_{CE0}$ | 30 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 750 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Static Characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 40 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | 50 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 65 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 . . . 120 | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 35 (> 20) | |
| Collector saturation voltage | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 0.15 (< 0.6) | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | 0.5 (< 1.2) | V |
| Base saturation voltage | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB} = 60$ V | $I_{CB0}$ | 0.5 (< 10) | nA |
| at $V_{CB} = 60$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | 0.4 (< 10) | µA |
| Emitter cutoff current | | | |
| at $V_{EB} = 5$ V | $I_{EB0}$ | 1 (< 10) | nA |

| | | | |
|---|---|---|---|
| Collector base capacitance<br>at $V_{CB0} = 10$ V | $C_{CB0}$ | 6.5 (< 10) | pF |
| Emitter base capacitance<br>at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 23 (< 33) | pF |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{th\,A}$<br>$R_{th\,C}$ | <br>< 220<br>< 58 | <br>°C/W<br>°C/W |

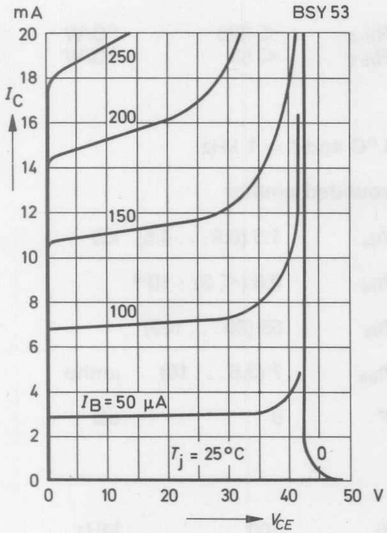
**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

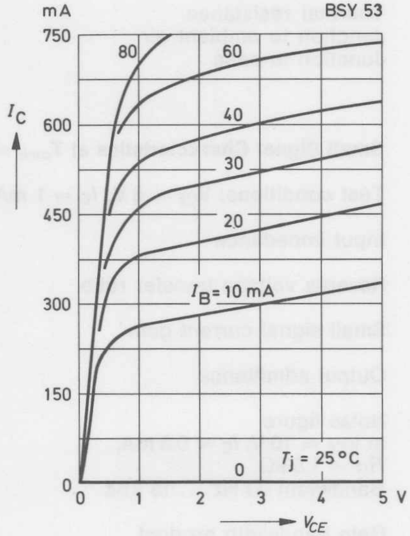
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 1.5 (0.8 . . . 4.5) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | 0.8 (< 3) · $10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 55 (30 . . . 100) | |
| Output admittance | $h_{oe}$ | 7 (3.5 . . . 10) | μmho |
| Noise figure<br>at $V_{CE} = 10$ V, $I_C = 0.3$ mA,<br>$R_G = 1.5$ kΩ,<br>Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |

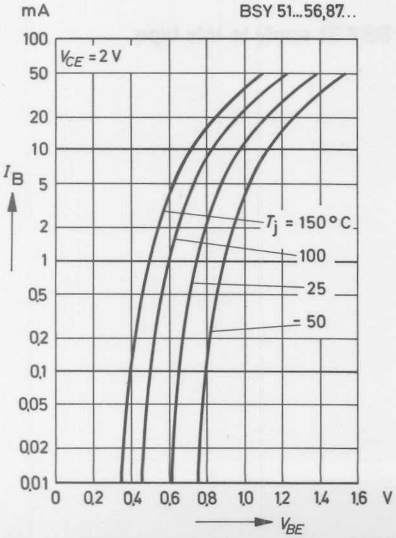
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

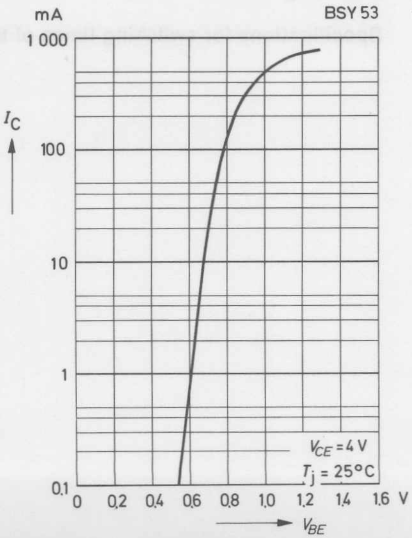


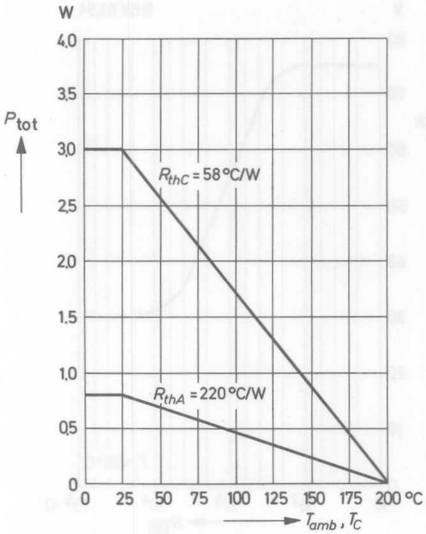

**Common emitter input characteristics**



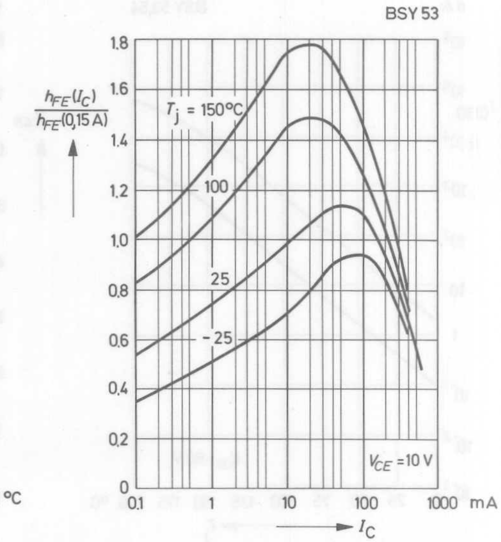

**Collector current versus base emitter voltage**



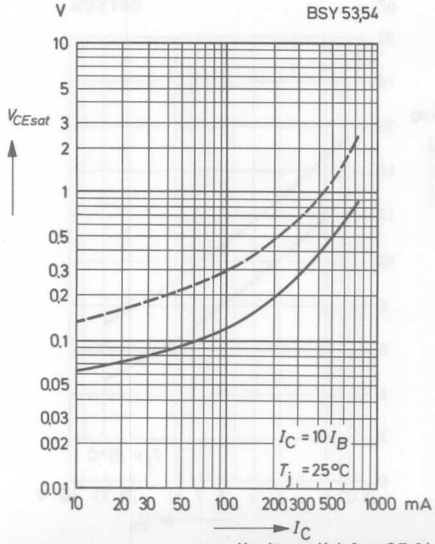
**Admissible power dissipation versus temperature**



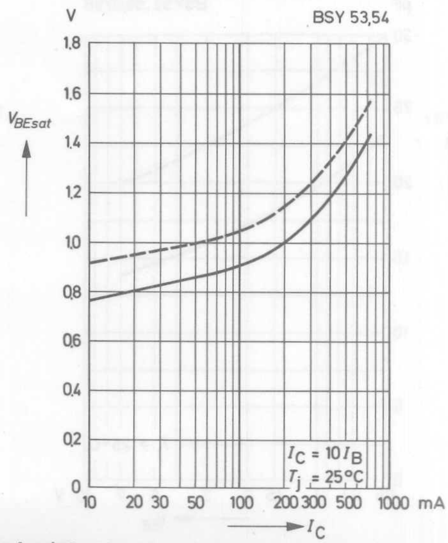

**Relative DC current gain versus collector current**




**Collector saturation voltage versus collector current**

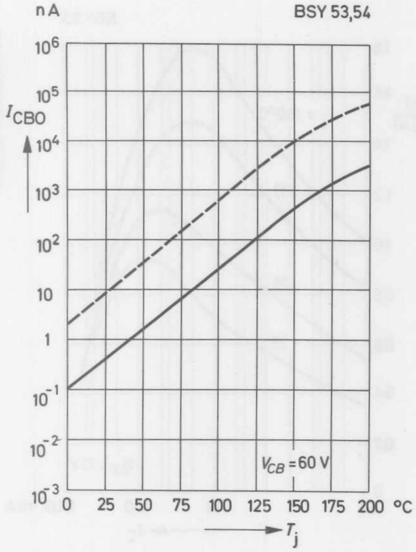



**Base saturation voltage versus collector current**

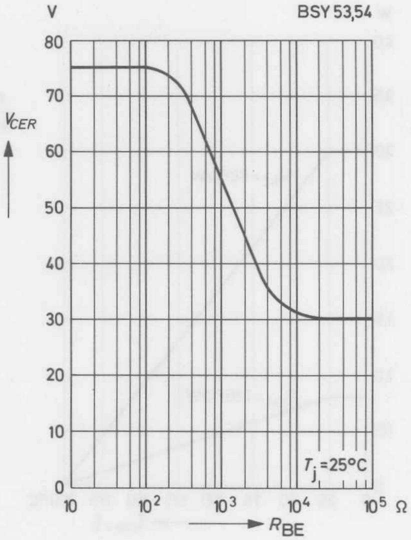



– – – – upper limit, valid for 95 % of a lot

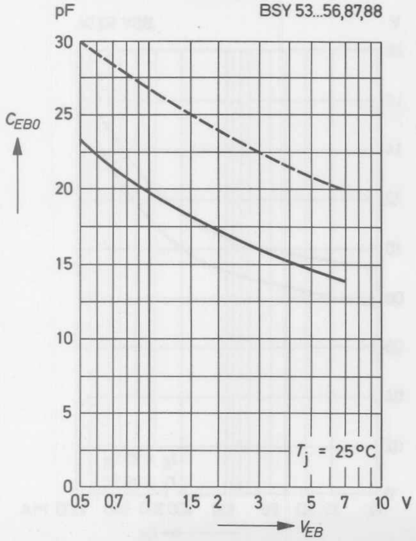
**Collector cutoff current versus junction temperature**



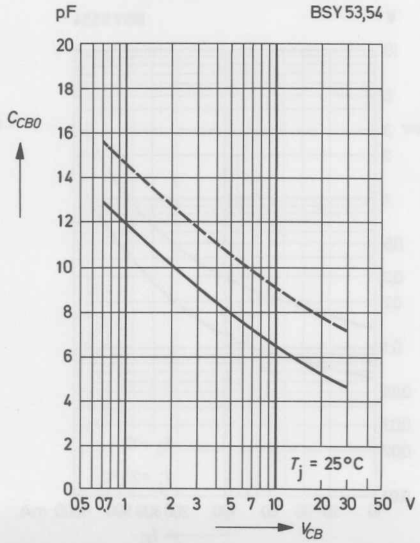

**Admissible collector emitter voltage versus base emitter resistance**




**Emitter base capacitance versus emitter base voltage**

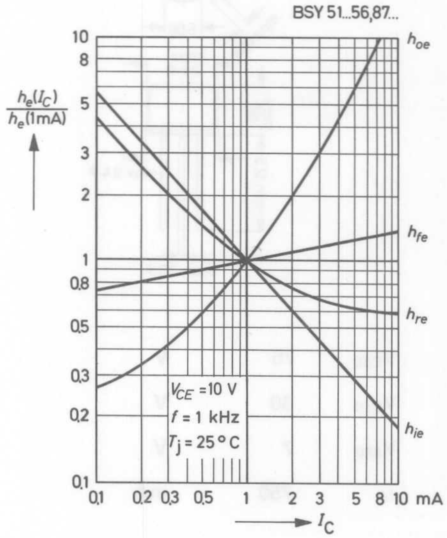



**Collector base capacitance versus collector base voltage**

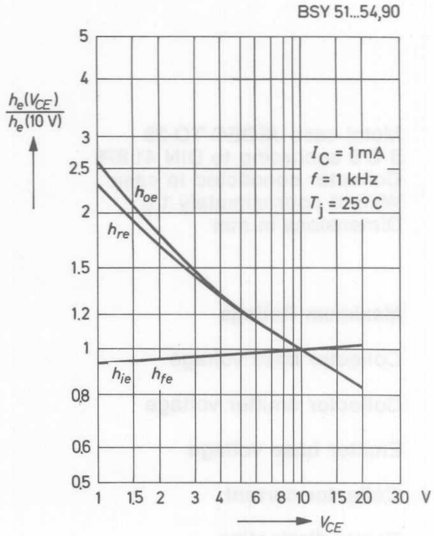



---- upper limit, valid for 95 % of a lot

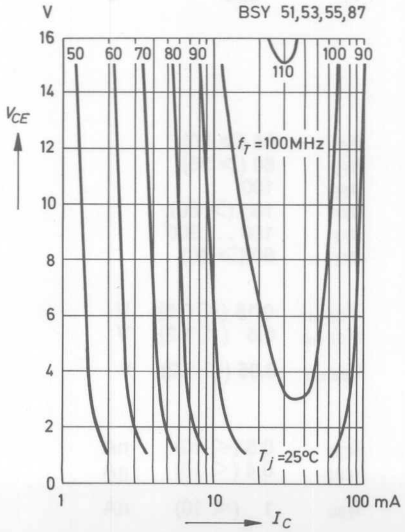
**Relative *h*-parameters versus collector current**



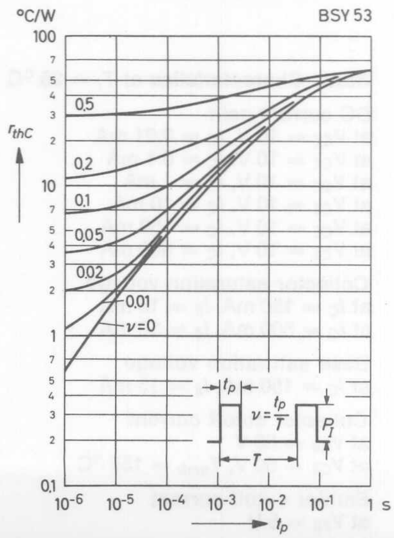

**Relative *h*-parameters versus collector emitter voltage**




**Contours of constant gain bandwidth product**

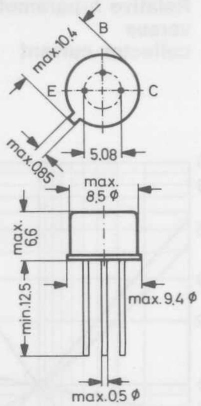



**Pulse thermal resistance versus pulse duration**



# BSY 54 ≈ 2 N 1711

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 75 | V |
| Collector emitter voltage | $V_{CE0}$ | 30 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 750 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Static Characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE}$ = 10 V, $I_C$ = 0.01 mA | $h_{FE}$ | 55 (> 20) | |
| at $V_{CE}$ = 10 V, $I_C$ = 0.1 mA | $h_{FE}$ | 80 (> 35) | |
| at $V_{CE}$ = 10 V, $I_C$ = 1 mA | $h_{FE}$ | 100 | |
| at $V_{CE}$ = 10 V, $I_C$ = 10 mA | $h_{FE}$ | 135 (> 80) | |
| at $V_{CE}$ = 10 V, $I_C$ = 150 mA | $h_{FE}$ | 100 . . . 300 | |
| at $V_{CE}$ = 10 V, $I_C$ = 500 mA | $h_{FE}$ | 60 (> 40) | |
| Collector saturation voltage | | | |
| at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{CE\,sat}$ | 0.15 (< 0.6) | V |
| at $I_C$ = 500 mA, $I_B$ = 50 mA | $V_{CE\,sat}$ | 0.5 (< 1.2) | V |
| Base saturation voltage | | | |
| at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB}$ = 60 V | $I_{CB0}$ | 0.5 (< 10) | nA |
| at $V_{CB}$ = 60 V, $T_{amb}$ = 150 °C | $I_{CB0}$ | 0.4 (< 10) | µA |
| Emitter cutoff current | | | |
| at $V_{EB}$ = 5 V | $I_{EB0}$ | 1 (< 10) | nA |

| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 6.5 (< 10) | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 23 (< 33) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{th\,A}$ | < 220 | °C/W |
| Junction to case | $R_{th\,C}$ | < 58 | °C/W |

**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

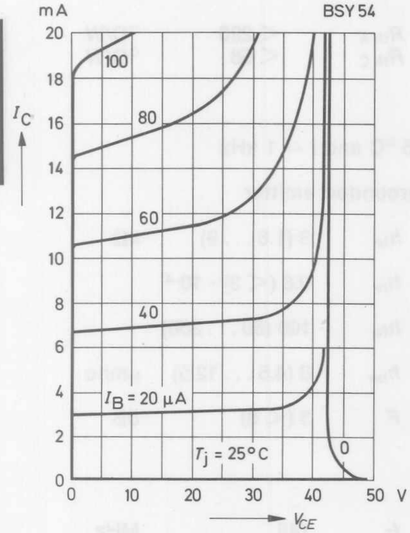
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 3 (1.6 . . . 9) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | $0.8\ (< 3) \cdot 10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 100 (50 . . . 250) | |
| Output admittance | $h_{oe}$ | 8 (4.5 . . . 12.5) | µmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 3 (< 8) | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 145 | MHz |

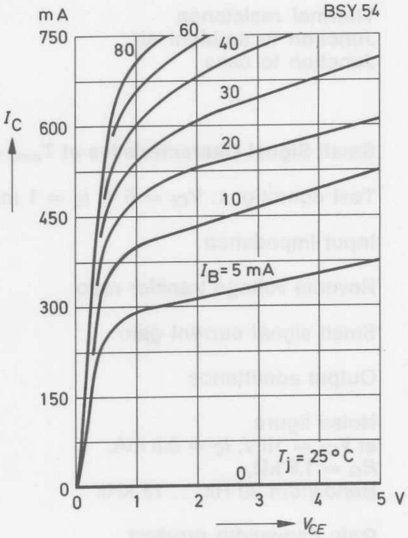
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

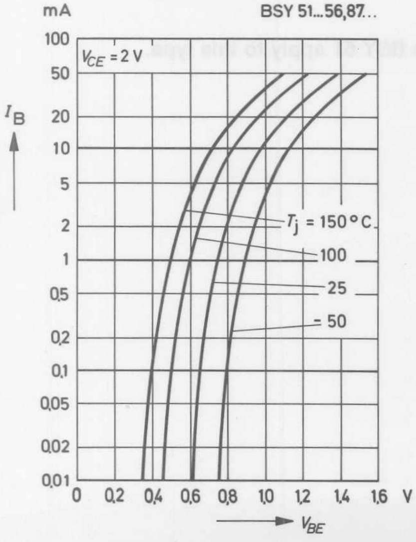
**Common emitter collector characteristics**



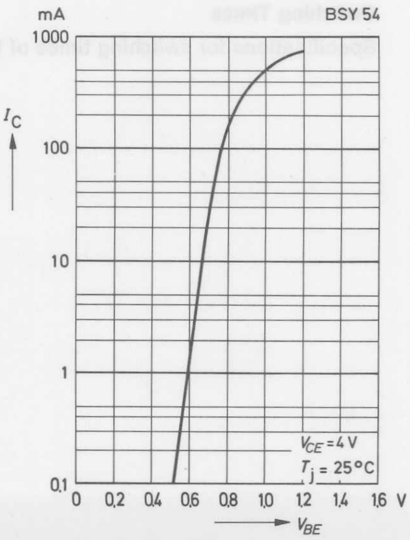

**Common emitter collector characteristics**



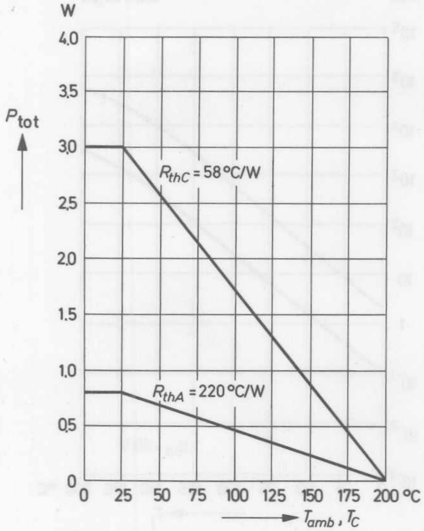

**Common emitter input characteristics**



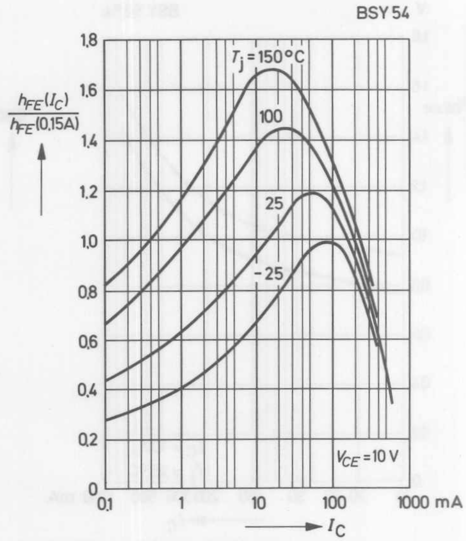

**Collector current versus base emitter voltage**



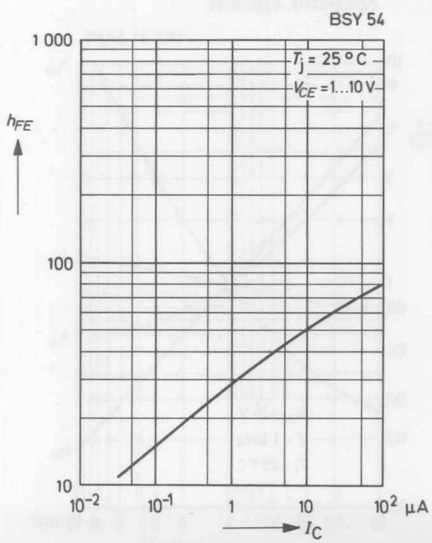
**Admissible power dissipation versus temperature**



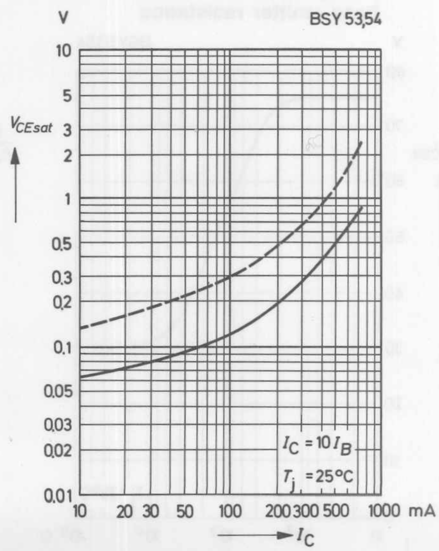

**Relative DC current gain versus collector current**




**DC current gain versus small collector current**

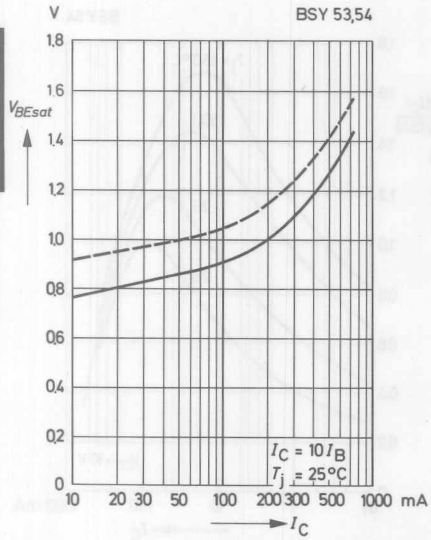



**Collector saturation voltage versus collector current**



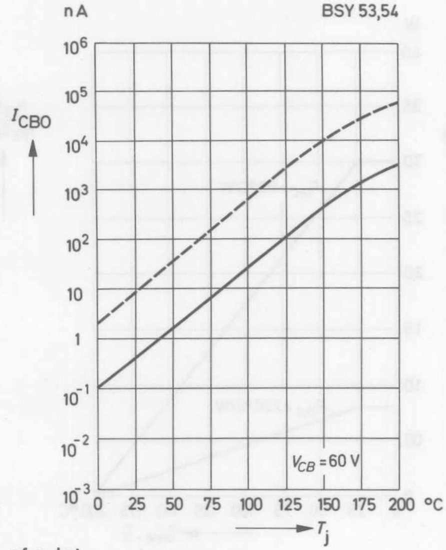

– – – – upper limit, valid for 95 % of a lot

**Base saturation voltage versus collector current**

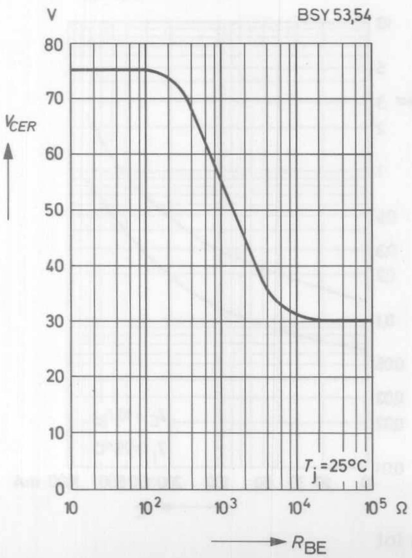



– – – – upper limit, valid for 95 % of a lot

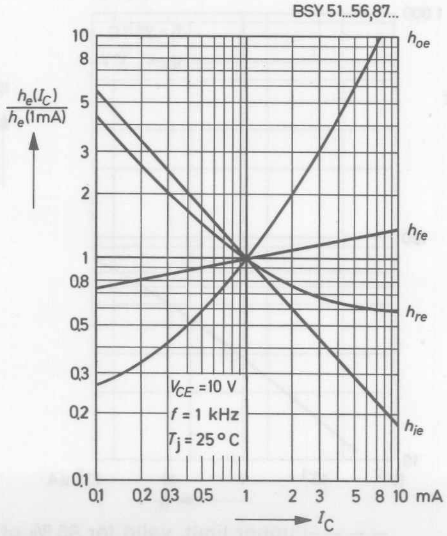
**Collector cutoff current versus junction temperature**



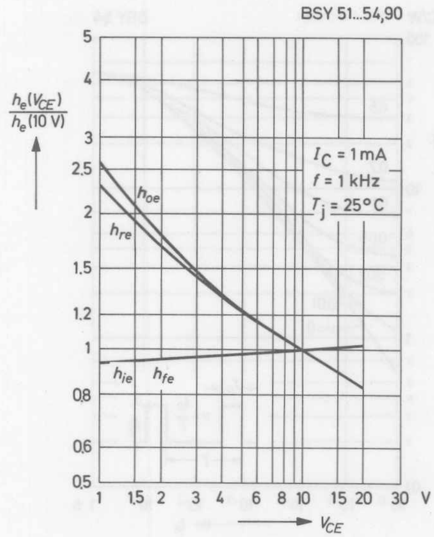

**Admissible collector emitter voltage versus base emitter resistance**



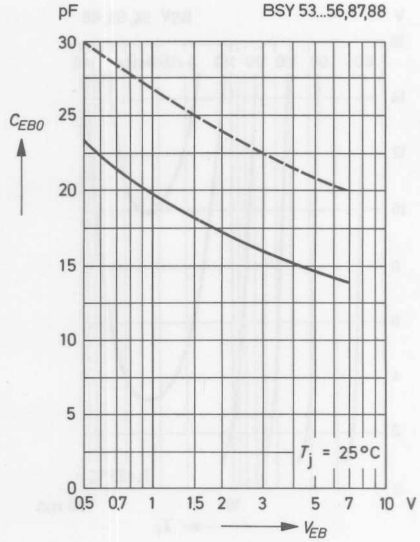

**Relative *h*-parameters versus collector current**



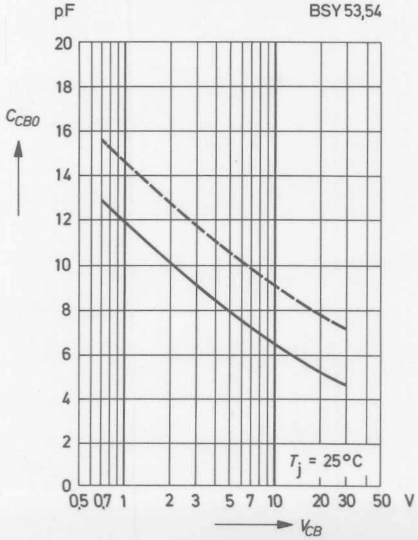
**Relative *h*-parameters versus collector emitter voltage**



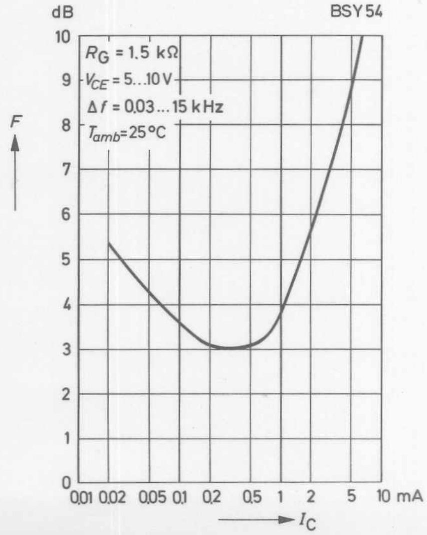

**Emitter base capacitance versus emitter base voltage**




**Collector base capacitance versus collector base voltage**

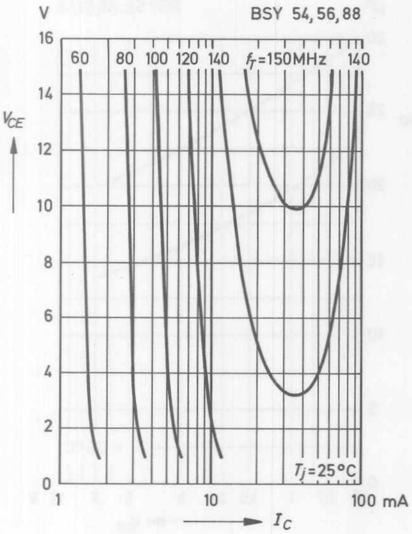



**Noise figure versus collector current**

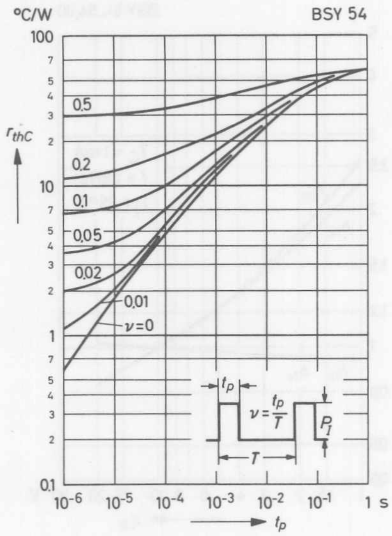



– – – – upper limit, valid for 95 % of a lot

**Contours of constant gain bandwidth product**

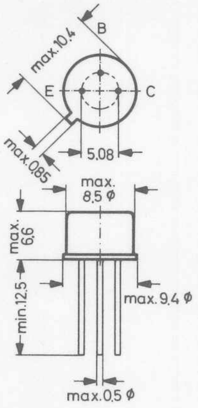



**Pulse thermal resistance versus pulse duration**



# BSY 55 ≈ 2 N 1893

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 120 | V |
| Collector emitter voltage | $V_{CEO}$ | 80 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Static Characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE}$ = 10 V, $I_C$ = 0.1 mA | $h_{FE}$ | 50 (> 20) | |
| at $V_{CE}$ = 10 V, $I_C$ = 1 mA | $h_{FE}$ | 60 | |
| at $V_{CE}$ = 10 V, $I_C$ = 10 mA | $h_{FE}$ | 65 (> 35) | |
| at $V_{CE}$ = 10 V, $I_C$ = 150 mA | $h_{FE}$ | 40 . . . 120 | |
| at $V_{CE}$ = 10 V, $I_C$ = 500 mA | $h_{FE}$ | 20 | |
| Collector saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{CE\,sat}$ | 0.2 (< 0.6) | V |
| Base saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{BE\,sat}$ | 1 (< 1.3) | V |
| Collector cutoff current | | | |
| at $V_{CB}$ = 90 V | $I_{CBO}$ | 0.5 (< 10) | nA |
| at $V_{CB}$ = 90 V, $T_{amb}$ = 150 °C | $I_{CBO}$ | 0.4 (< 10) | µA |
| Emitter cutoff current at $V_{EB}$ = 5 V | $I_{EBO}$ | 1 (< 10) | nA |
| Collector base capacitance at $V_{CBO}$ = 10 V | $C_{CBO}$ | 6 (< 10) | pF |

| | | | |
|---|---|---|---|
| Emitter base capacitance at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 23 (< 33) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{th\,A}$ | < 220 | °C/W |
| Junction to case | $R_{th\,C}$ | < 58 | °C/W |

**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

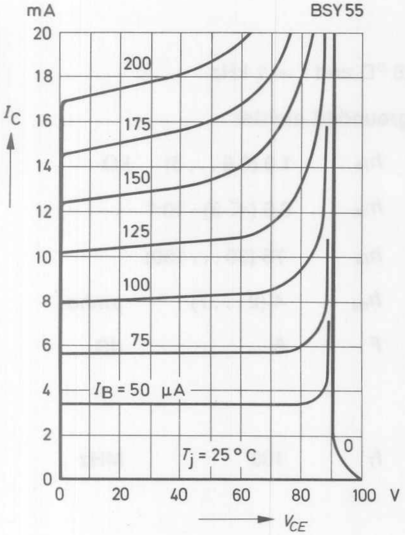
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 1.6 (0.8 . . . 5) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | 0.6 (< 3) · $10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 75 (30 . . . 150) | |
| Output admittance | $h_{oe}$ | 4 (2 . . . 7) | μmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |

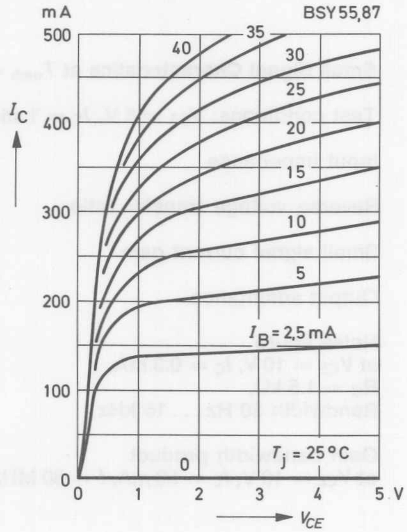
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

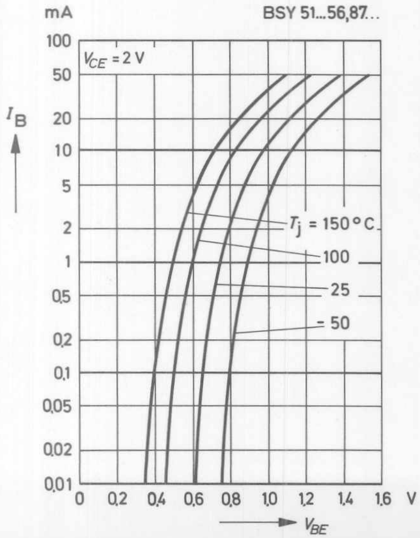
**Common emitter collector characteristics**



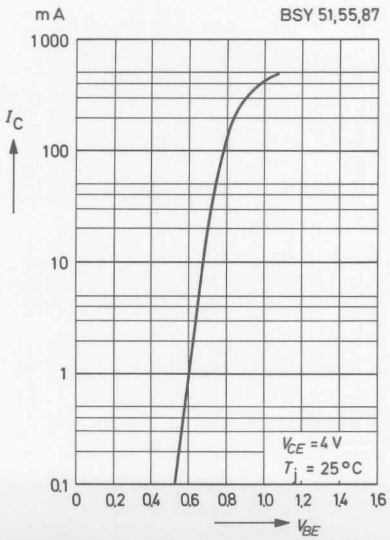

**Common emitter collector characteristics**



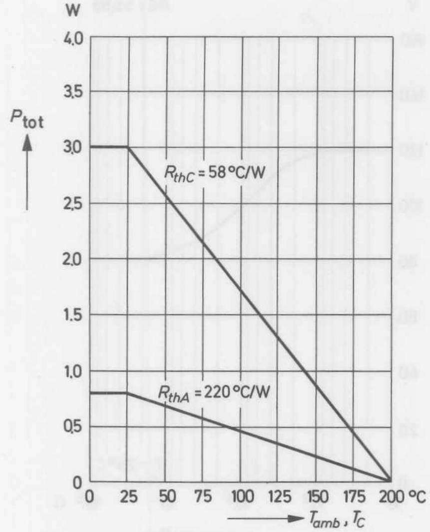

**Common emitter input characteristics**



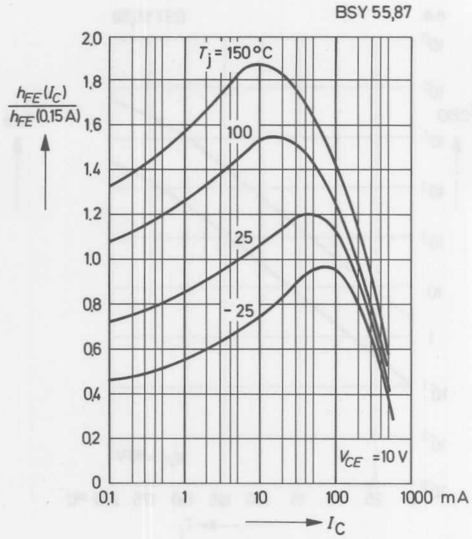

**Collector current versus base emitter voltage**



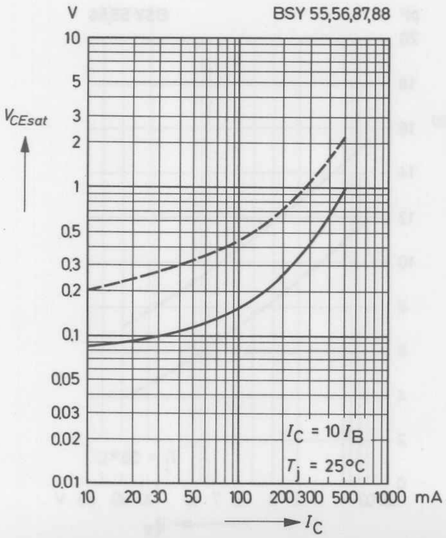
**Admissible power dissipation versus temperature**



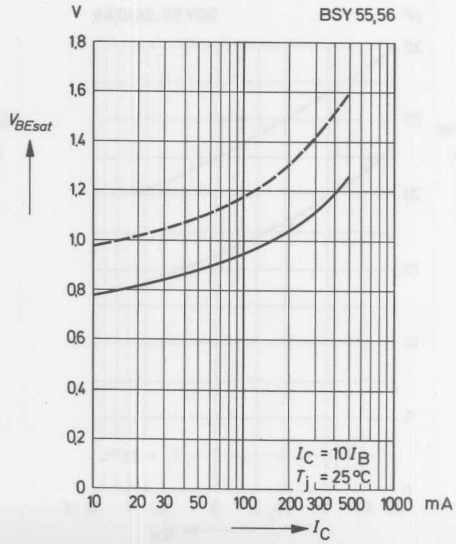

**Relative DC current gain versus collector current**




**Collector saturation voltage versus collector current**

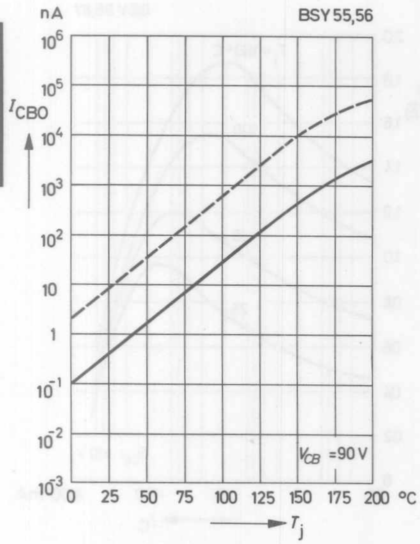



**Base saturation voltage versus collector current**

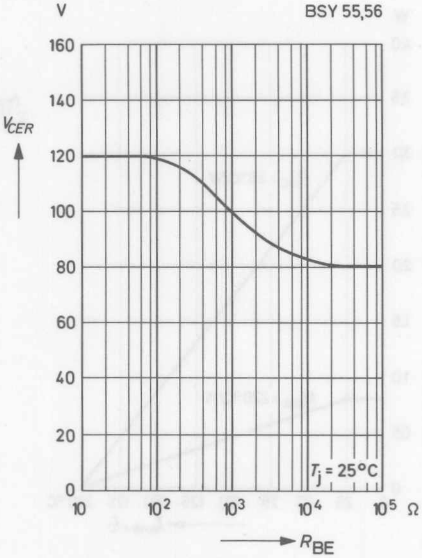



– – – – upper limit, valid for 95 % of a lot

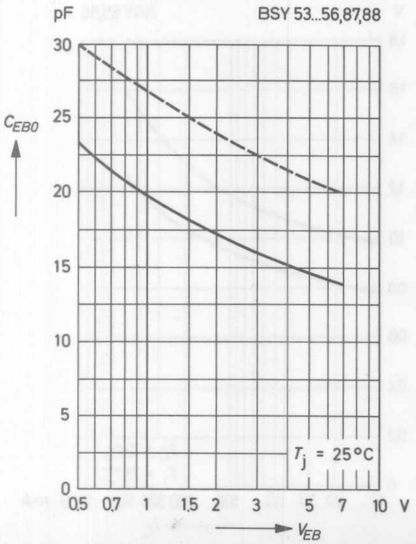
**Collector cutoff current versus junction temperature**



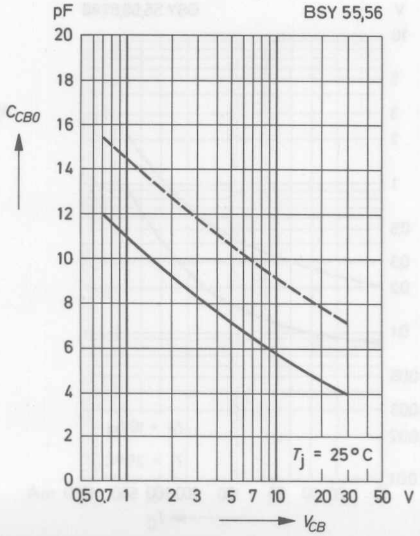

**Admissible collector emitter voltage versus base emitter resistance**




**Emitter base capacitance versus emitter base voltage**

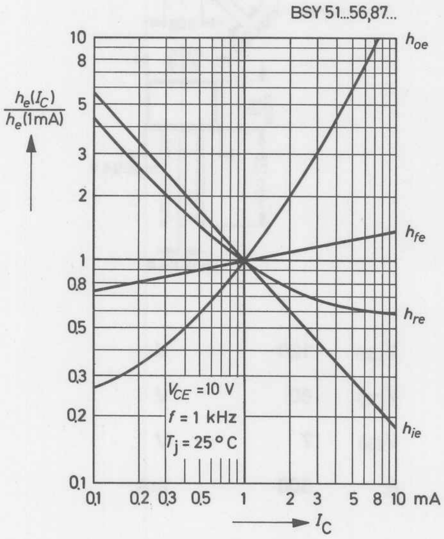



**Collector base capacitance versus collector base voltage**

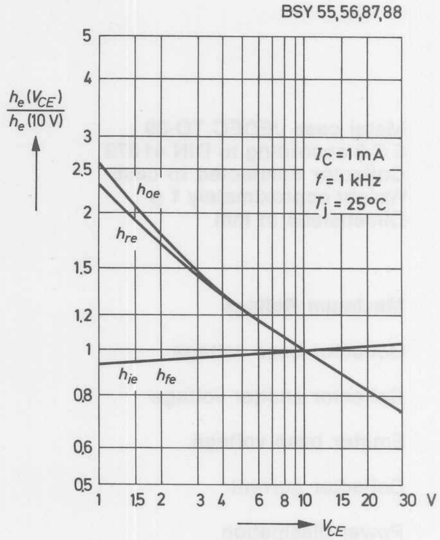



– – – – upper limit, valid for 95 % of a lot

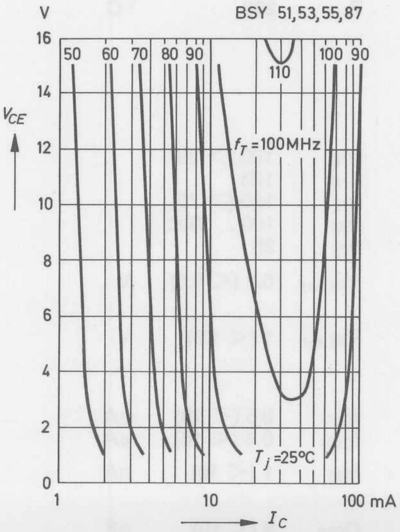
## Relative *h*-parameters versus collector current



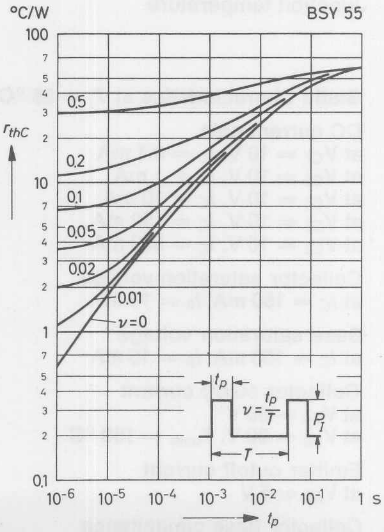

## Relative *h*-parameters versus collector emitter voltage




## Contours of constant gain bandwidth product

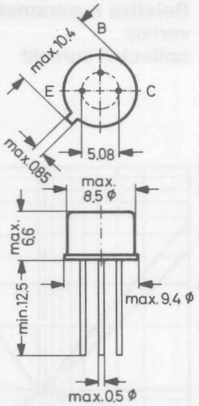



## Pulse thermal resistance versus pulse duration



# BSY 56

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 120 | V |
| Collector emitter voltage | $V_{CEO}$ | 80 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Static Characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 100 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | 125 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 180 (> 75) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 100 . . . 300 | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 35 | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 0.2 (< 0.6) | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 1 (< 1.3) | V |
| Collector cutoff current | | | |
| at $V_{CB} = 90$ V | $I_{CBO}$ | 0.5 (< 10) | nA |
| at $V_{CB} = 90$ V, $T_{amb} = 150$ °C | $I_{CBO}$ | 0.4 (< 10) | µA |
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EBO}$ | 1 (< 10) | nA |
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 6 (< 10) | pF |

| | | | |
|---|---|---|---|
| Emitter base capacitance at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 23 (< 33) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{th\,A}$ | < 220 | °C/W |
| Junction to case | $R_{th\,C}$ | < 58 | °C/W |

**Small Signal Characteristics** at $T_{amb} = 25\,°C$ and $f = 1$ kHz

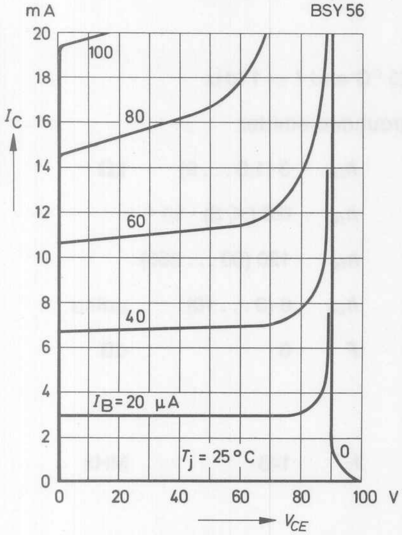
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 3 (1.6 . . . 9) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | $0.6\ (< 3) \cdot 10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 120 (60 . . . 280) | |
| Output admittance | $h_{oe}$ | 6 (3 . . . 10) | µmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 145 | MHz |

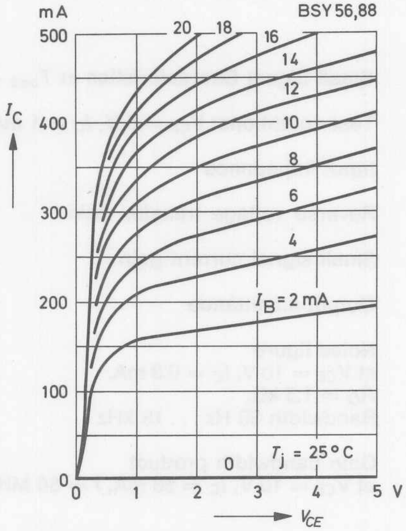
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

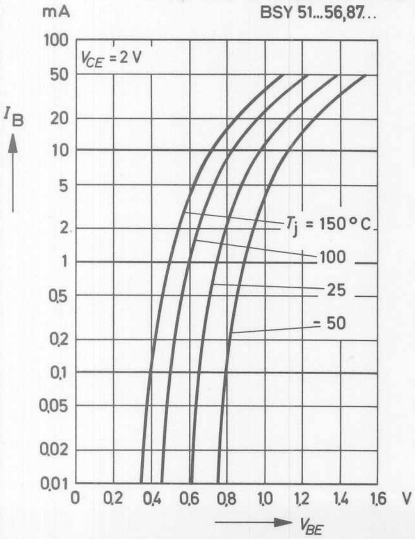
**Common emitter collector characteristics**



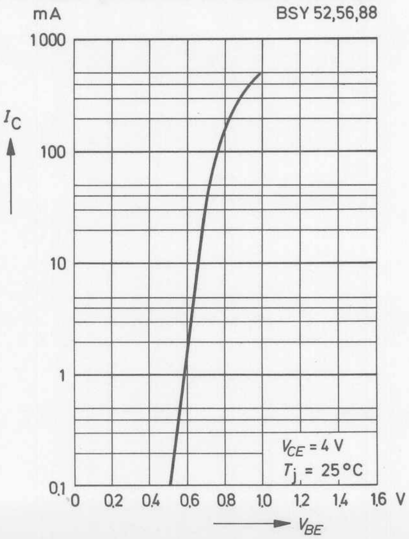

**Common emitter collector characteristics**



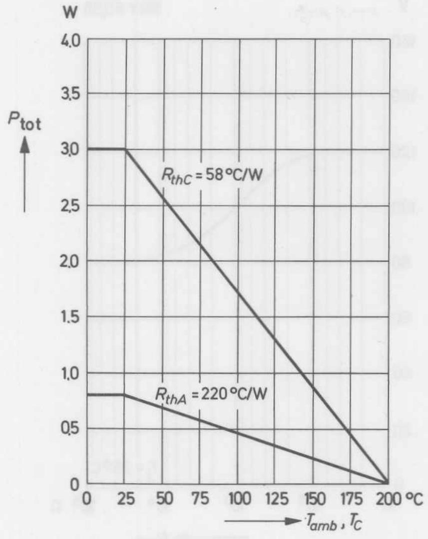

**Common emitter input characteristics**



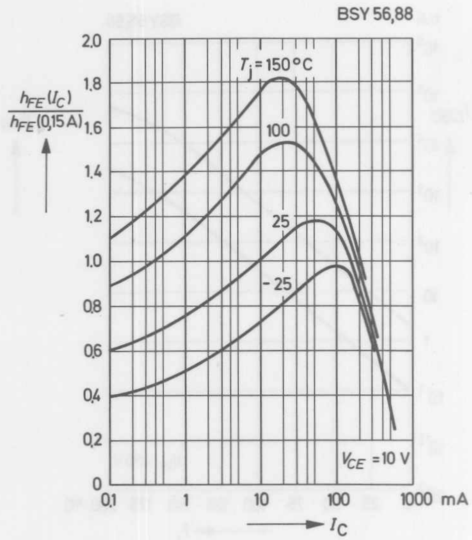

**Collector current versus base emitter voltage**



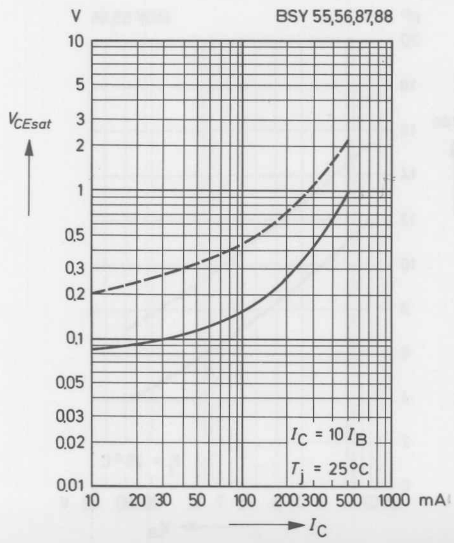
**Admissible power dissipation versus temperature**



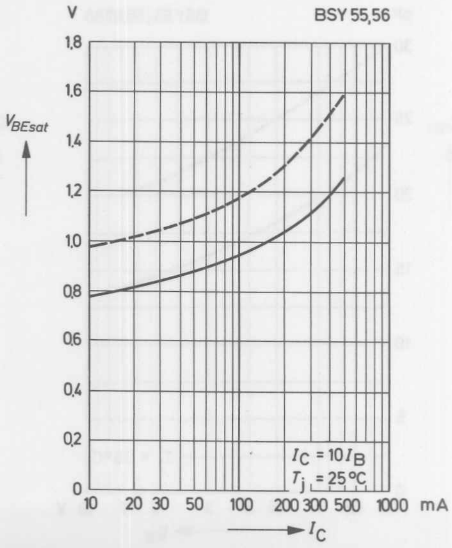

**Relative DC current gain versus collector current**




**Collector saturation voltage versus collector current**

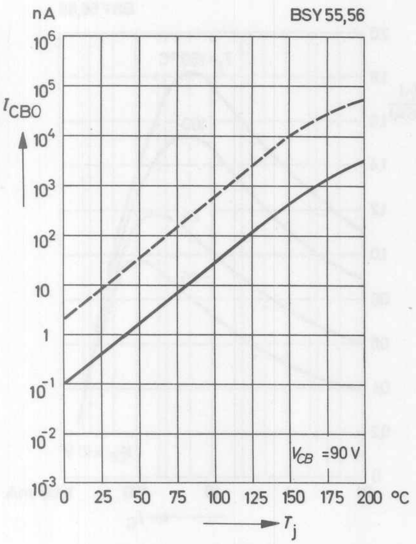



**Base saturation voltage versus collector current**

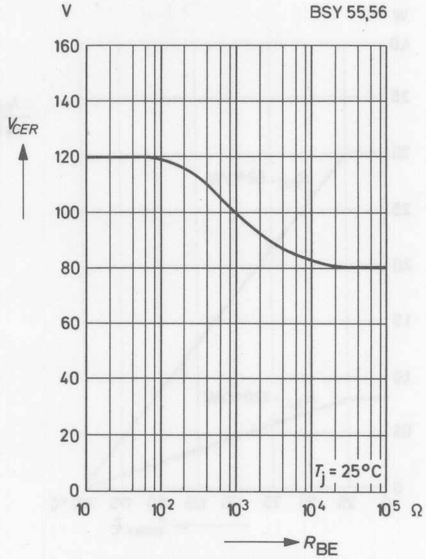



– – – – upper limit, valid for 95 % of a lot

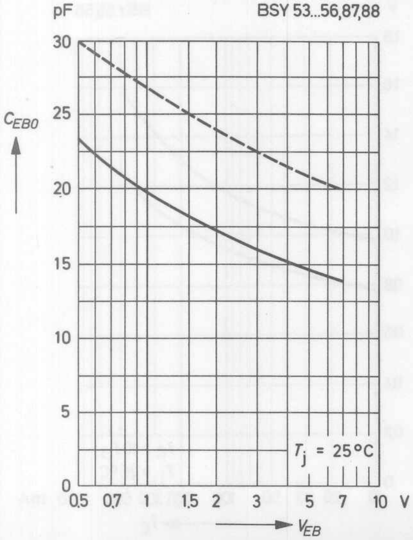
**Collector cutoff current versus junction temperature**



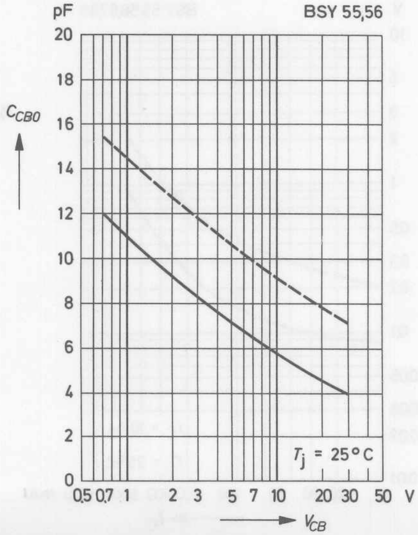

**Admissible collector emitter voltage versus base emitter resistance**




**Emitter base capacitance versus emitter base voltage**

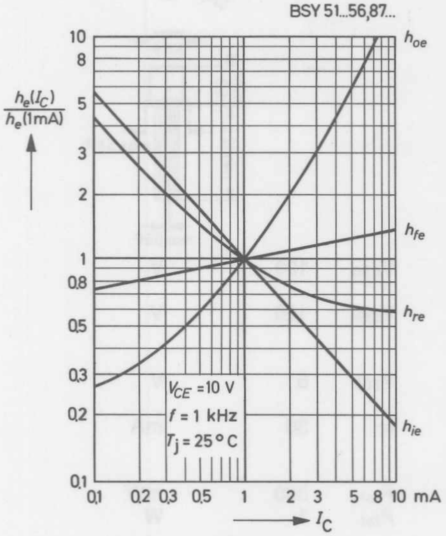



**Collector base capacitance versus collector base voltage**

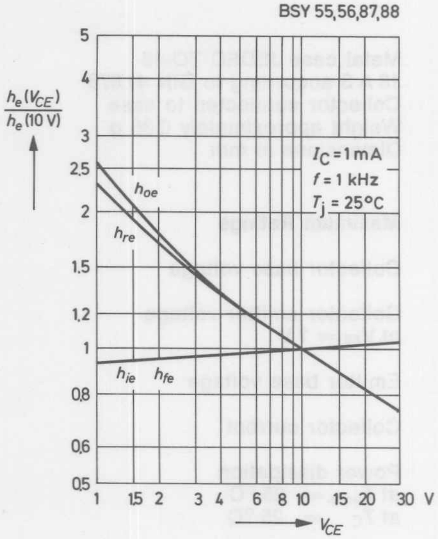



– – – – upper limit, valid for 95 % of a lot

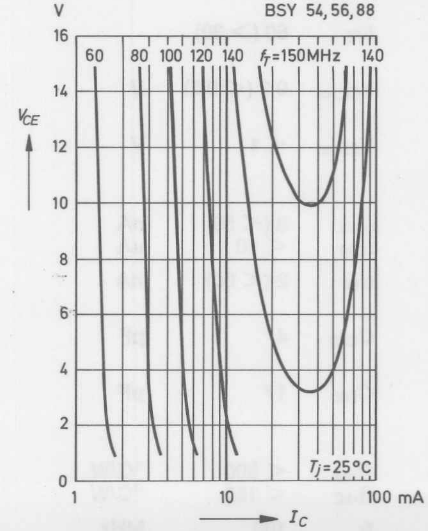
**Relative *h*-parameters versus collector current**



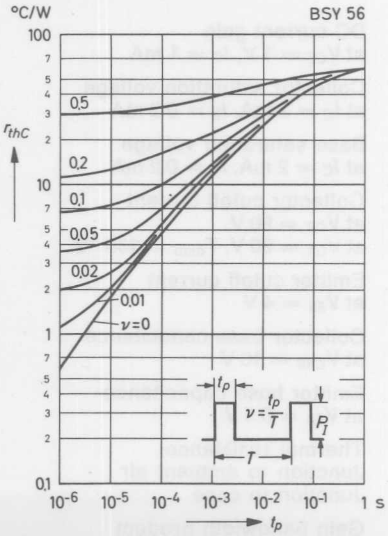

**Relative *h*-parameters versus collector emitter voltage**




**Contours of constant gain bandwidth product**

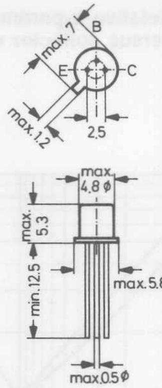



**Pulse thermal resistance versus pulse duration**



# BSY 79

**NPN Silicon Epitaxial Planar Transistor**
with high collector emitter voltage for use as driver
for numerical indicator tubes (Nixie driver)




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

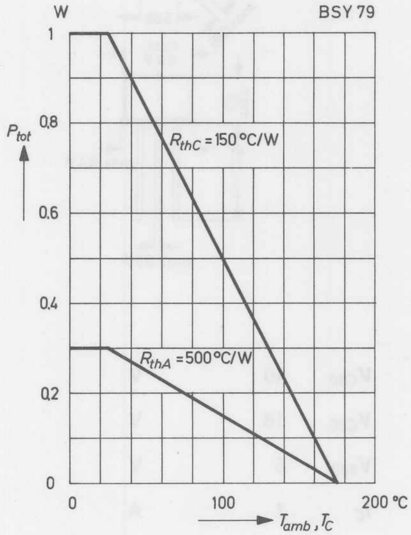
**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 120 | V |
| Collector emitter voltage at $V_{EB} = 1$ V | $V_{CEV}$ | 120 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 30 | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 300 | mW |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1 | W |
| Junction temperature | $T_j$ | 175 | °C |

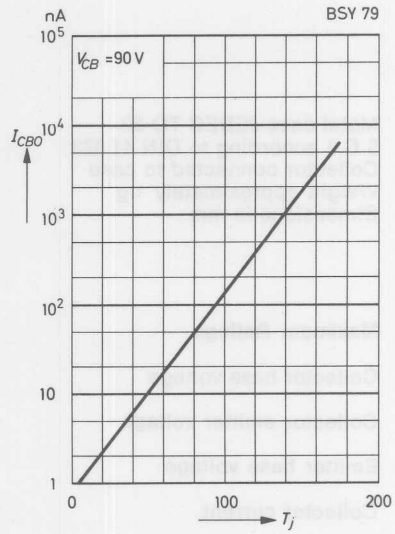
**Characteristics** at $T_j = 25\ °C$

| | | | |
|---|---|---|---|
| DC current gain at $V_{CE} = 1$ V, $I_C = 1$ mA | $h_{FE}$ | 60 (> 30) | |
| Collector saturation voltage at $I_C = 2$ mA, $I_B = 0.2$ mA | $V_{CE\,sat}$ | 0.3 (< 0.5) | V |
| Base saturation voltage at $I_C = 2$ mA, $I_B = 0.2$ mA | $V_{BE\,sat}$ | < 1 | V |
| Collector cutoff current at $V_{CB} = 90$ V | $I_{CBO}$ | 3 (< 50) | nA |
| at $V_{CB} = 90$ V, $T_{amb} = 150\ °C$ | $I_{CBO}$ | < 10 | µA |
| Emitter cutoff current at $V_{EB} = 4$ V | $I_{EBO}$ | 2 (< 50) | nA |
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 4 | pF |
| Emitter base capacitance at $V_{EB} = 0.5$ V | $C_{EBO}$ | 17 | pF |
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 500 | °C/W |
| Junction to case | $R_{thC}$ | < 150 | °C/W |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 10$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |

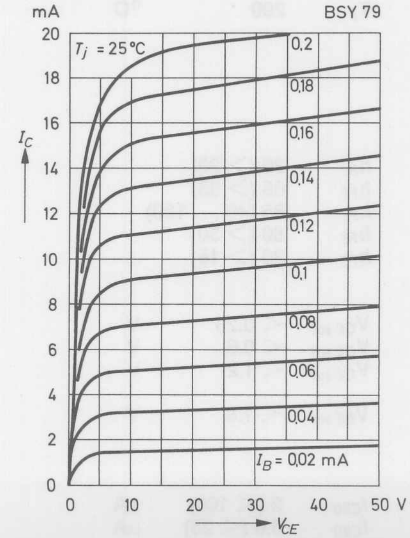
## Admissible power dissipation versus temperature



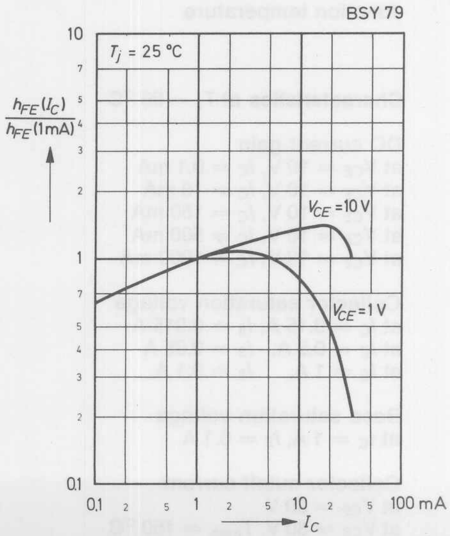

## Collector cutoff current versus junction temperature




## Common emitter collector characteristics

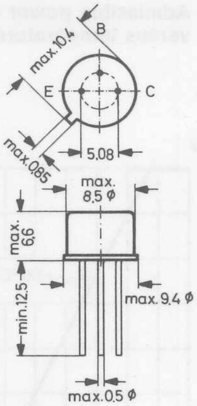



## Relative DC current gain versus collector current



# BSY 81

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications
at higher collector current




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

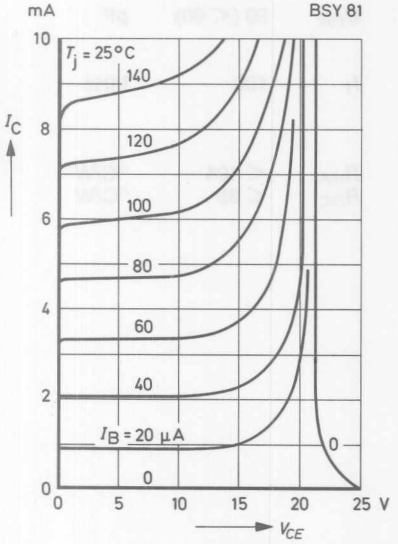
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 40 | V |
| Collector emitter voltage | $V_{CE0}$ | 18 | V |
| Emitter base voltage | $V_{EB0}$ | 5 | V |
| Collector current | $I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.9 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 2.8 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 5 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25$ °C

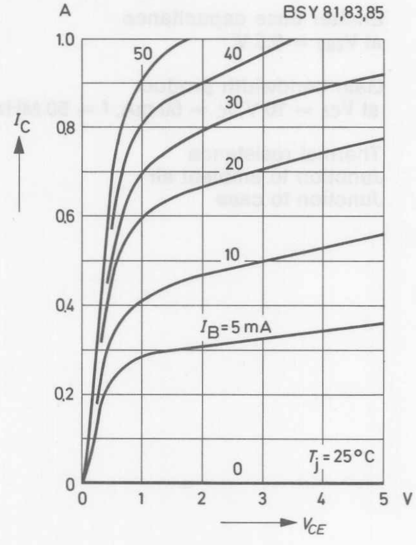
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 30 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 65 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 85 (40 . . . 120) | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 60 (> 30) | |
| at $V_{CE} = 10$ V, $I_C = 1000$ mA | $h_{FE}$ | 30 (> 15) | |
| Collector saturation voltage | | | |
| at $I_C = 0.15$ A, $I_B = 0.015$ A | $V_{CE\,sat}$ | < 0.25 | V |
| at $I_C = 0.5$ A, $I_B = 0.05$ A | $V_{CE\,sat}$ | < 0.6 | V |
| at $I_C = 1$ A, $I_B = 0.1$ A | $V_{CE\,sat}$ | < 1.2 | V |
| Base saturation voltage at $I_C = 1$ A, $I_B = 0.1$ A | $V_{BE\,sat}$ | < 1.8 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 30$ V | $I_{CB0}$ | 2 (< 100) | nA |
| at $V_{CB} = 30$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | 0.6 (< 25) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current<br>at $V_{EB} = 3$ V | $I_{EB0}$ | 3 (< 10) | nA |
| Collector base capacitance<br>at $V_{CB0} = 10$ V | $C_{CB0}$ | 8.5 (< 15) | pF |
| Emitter base capacitance<br>at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 50 (< 60) | pF |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{thA}$<br>$R_{thC}$ | <br>< 194<br>< 35 | <br>°C/W<br>°C/W |

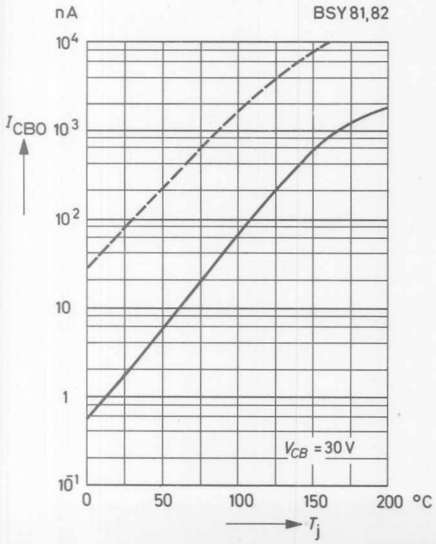
**Common emitter collector characteristics**



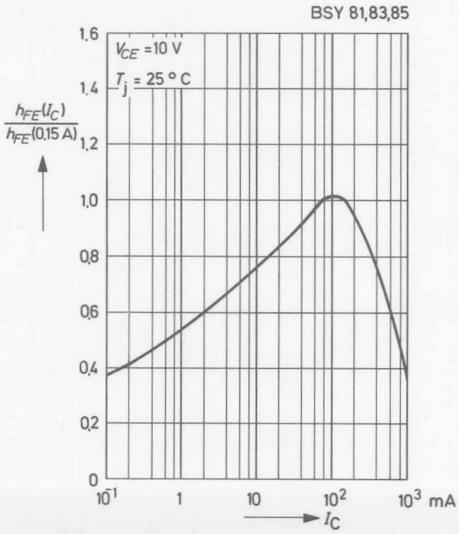

**Common emitter collector characteristics**




**Collector cutoff current versus junction temperature**

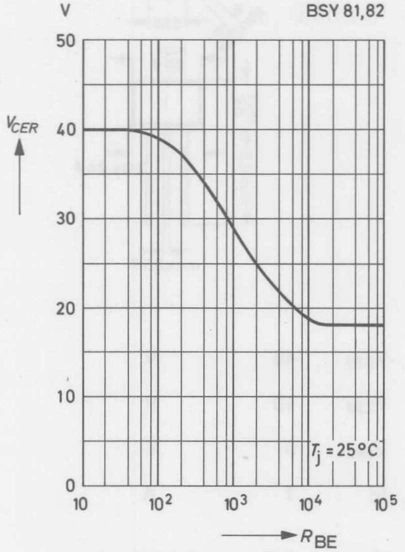



**Relative DC current gain versus collector current**

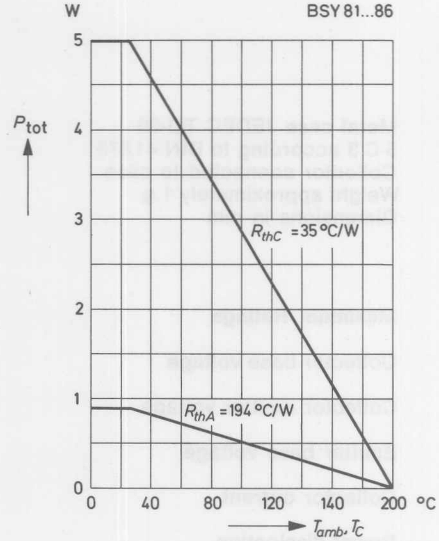



– – – – upper limit, valid for 95 % of a lot

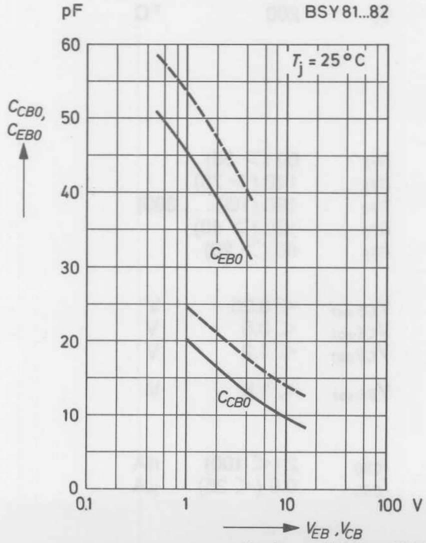
**Admissible collector emitter voltage versus base emitter resistance**




**Admissible power dissipation versus temperature**

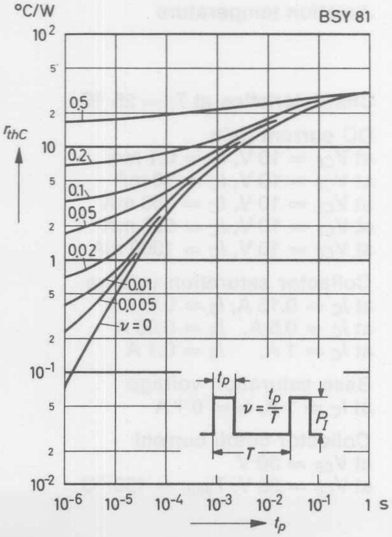



**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



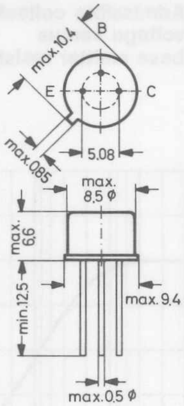

---- upper limit, valid for 95 % of a lot

**Pulse thermal resistance versus pulse duration**



# BSY 82

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications
at higher collector current




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

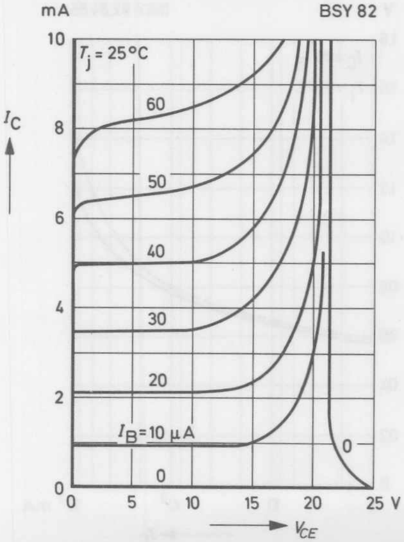
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | V |
| Collector emitter voltage | $V_{CEO}$ | 18 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.9 | W |
| at $T_C = 100\ °C$ | $P_{tot}$ | 2.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 5 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25\ °C$

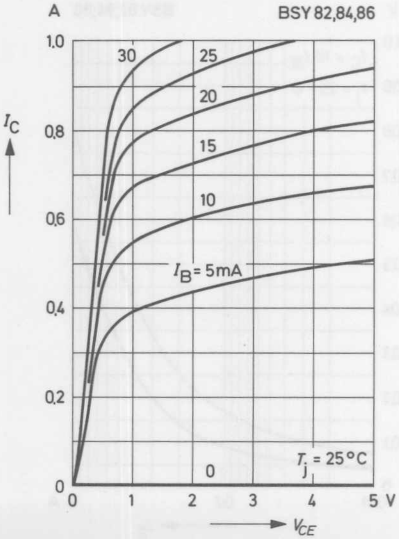
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 60 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 140 (> 75) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 190 (100 . . . 300) | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 120 (> 40) | |
| at $V_{CE} = 10$ V, $I_C = 1000$ mA | $h_{FE}$ | 50 (> 20) | |
| Collector saturation voltage | | | |
| at $I_C = 0.15$ A, $I_B = 0.015$ A | $V_{CE\,sat}$ | < 0.25 | V |
| at $I_C = 0.5$ A, $I_B = 0.05$ A | $V_{CE\,sat}$ | < 0.6 | V |
| at $I_C = 1$ A, $I_B = 0.1$ A | $V_{CE\,sat}$ | < 1.2 | V |
| Base saturation voltage at $I_C = 1$ A, $I_B = 0.1$ A | $V_{BE\,sat}$ | < 1.8 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 30$ V | $I_{CBO}$ | 2 (< 100) | nA |
| at $V_{CB} = 30$ V, $T_{amb} = 150\ °C$ | $I_{CBO}$ | 0.6 (< 25) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current at $V_{EB} = 3$ V | $I_{EBO}$ | 3 (< 10) | nA |
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 8.5 (< 15) | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 50 (< 60) | pF |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 120 | MHz |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 194 | °C/W |
| Junction to case | $R_{thC}$ | < 35 | °C/W |

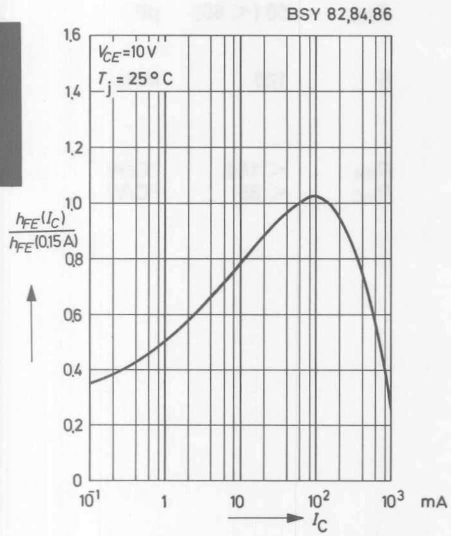
**Common emitter collector characteristics**



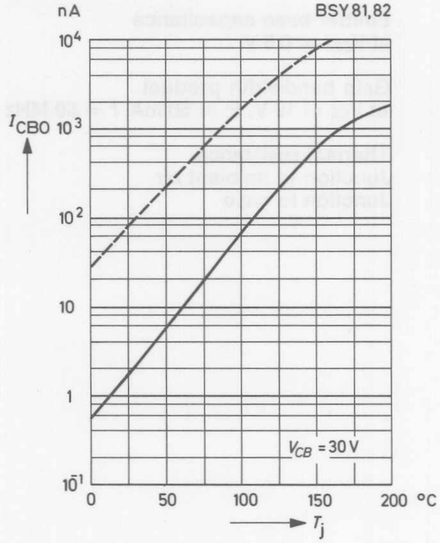

**Common emitter collector characteristics**



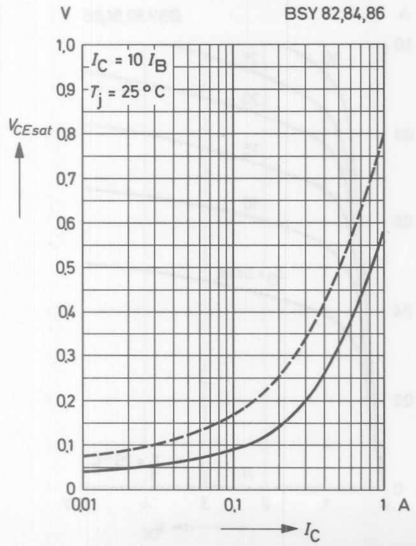
**Relative DC current gain versus collector current**



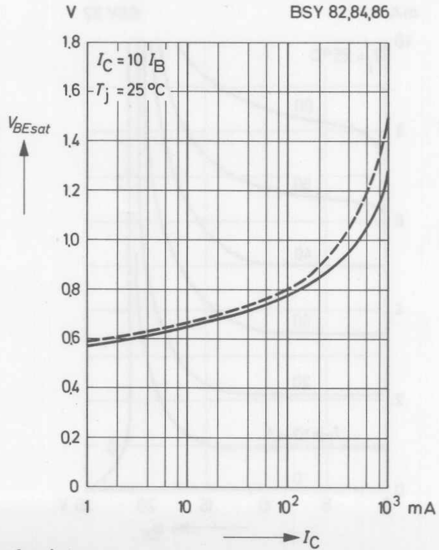

**Collector cutoff current versus junction temperature**




**Collector saturation voltage versus collector current**

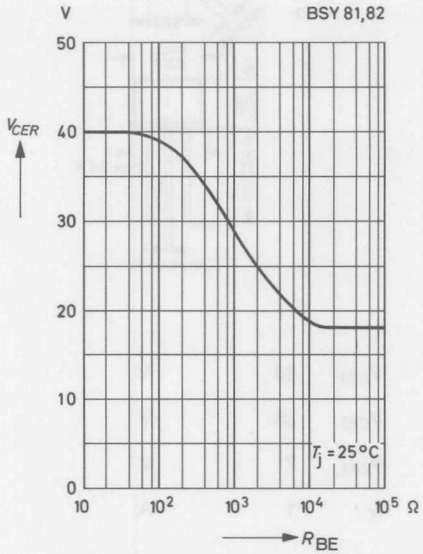



**Base saturation voltage versus collector current**

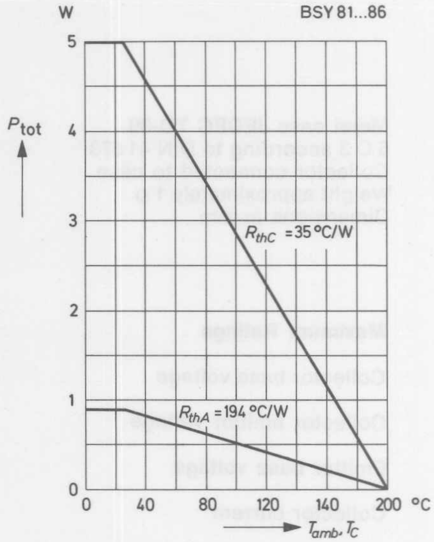



– – – – upper limit, valid for 95 % of a lot

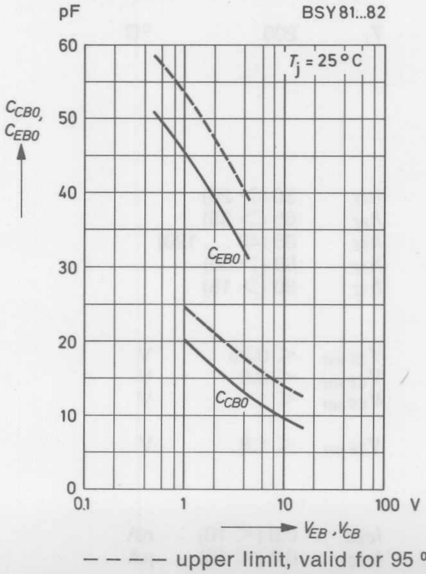
**Admissible collector emitter voltage versus base emitter resistance**



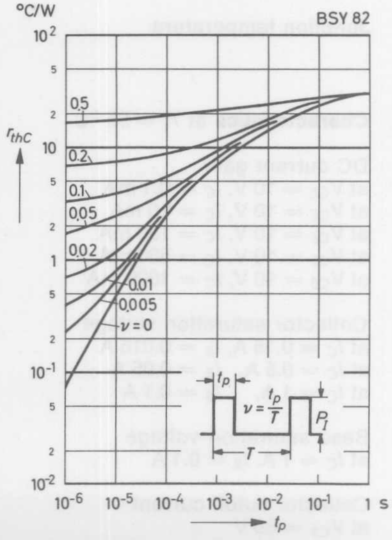

**Admissible power dissipation versus temperature**




**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



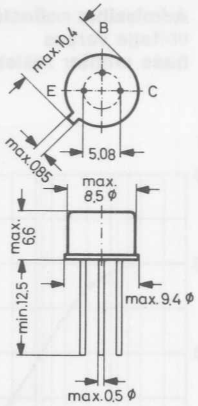

**Pulse thermal resistance versus pulse duration**




– – – – upper limit, valid for 95 % of a lot

# BSY 83 $\approx$ 2 N 2297

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications
at higher collector current




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

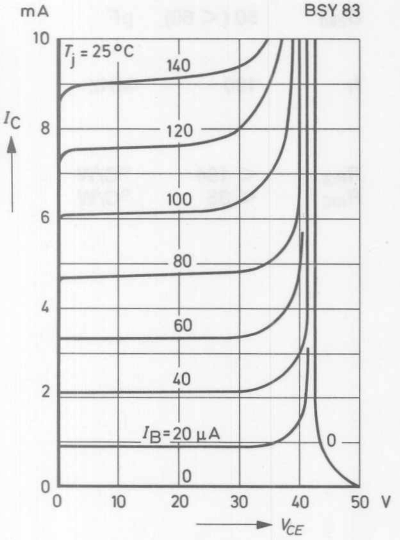
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 80 | V |
| Collector emitter voltage | $V_{CE0}$ | 35 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.9 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 2.8 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 5 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j$ = 25 °C

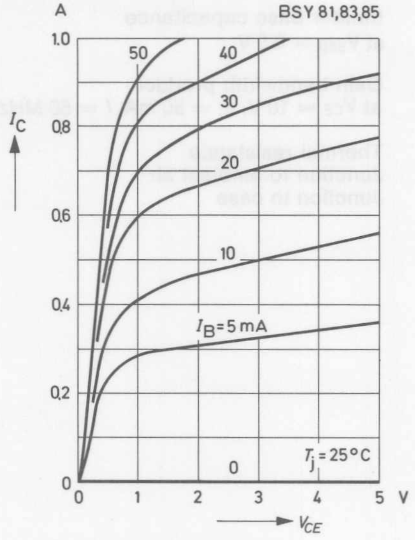
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE}$ = 10 V, $I_C$ = 0.1 mA | $h_{FE}$ | 30 (> 20) | |
| at $V_{CE}$ = 10 V, $I_C$ = 10 mA | $h_{FE}$ | 65 (> 35) | |
| at $V_{CE}$ = 10 V, $I_C$ = 150 mA | $h_{FE}$ | 85 (40 . . . 120) | |
| at $V_{CE}$ = 10 V, $I_C$ = 500 mA | $h_{FE}$ | 60 (> 30) | |
| at $V_{CE}$ = 10 V, $I_C$ = 1000 mA | $h_{FE}$ | 30 (> 15) | |
| Collector saturation voltage | | | |
| at $I_C$ = 0.15 A, $I_B$ = 0.015 A | $V_{CE\,sat}$ | < 0.25 | V |
| at $I_C$ = 0.5 A, $I_B$ = 0.05 A | $V_{CE\,sat}$ | < 0.6 | V |
| at $I_C$ = 1 A, $I_B$ = 0.1 A | $V_{CE\,sat}$ | < 1 | V |
| Base saturation voltage | $V_{BE\,sat}$ | < 1.8 | V |
| at $I_C$ = 1 A, $I_B$ = 0.1 A | | | |
| Collector cutoff current | | | |
| at $V_{CB}$ = 60 V | $I_{CB0}$ | 0.6 (< 10) | nA |
| at $V_{CB}$ = 60 V, $T_{amb}$ = 150 °C | $I_{CB0}$ | 0.3 (< 10) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current<br>at $V_{EB} = 3$ V | $I_{EB0}$ | 5 (< 10) | nA |
| Collector base capacitance<br>at $V_{CB0} = 10$ V | $C_{CB0}$ | 8.5 (< 15) | pF |
| Emitter base capacitance<br>at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 50 (< 60) | pF |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{thA}$<br>$R_{thC}$ | <br>< 194<br>< 35 | <br>°C/W<br>°C/W |

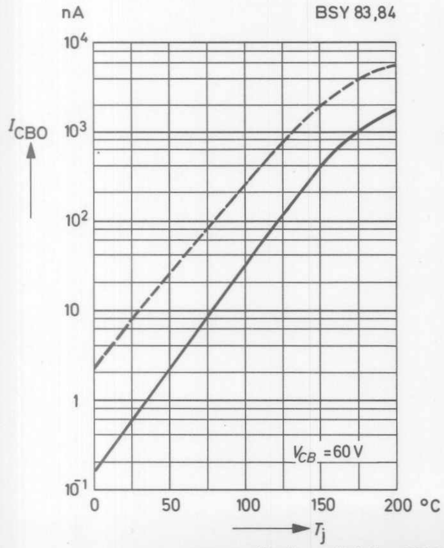
**Common emitter collector characteristics**



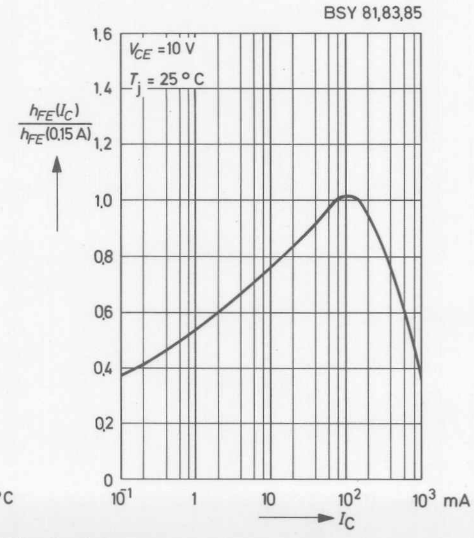

**Common emitter collector characteristics**




**Collector cutoff current versus junction temperature**

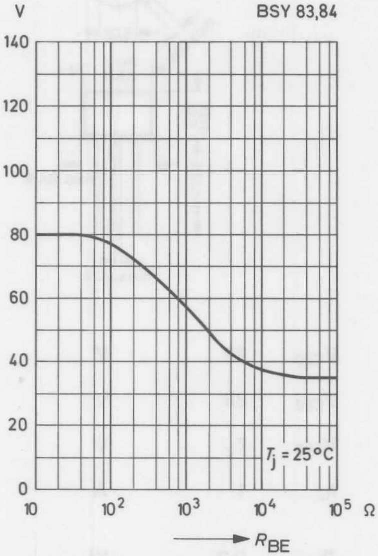



**Relative DC current gain versus collector current**

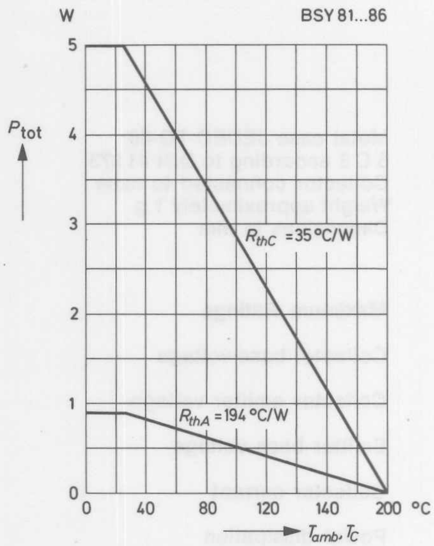



– – – – upper limit, valid for 95 % of a lot

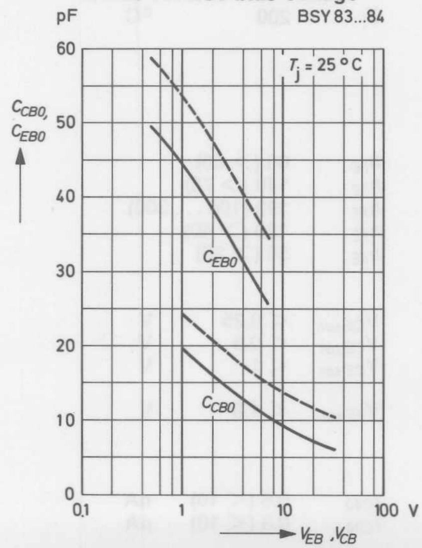
**Admissible collector emitter voltage versus base emitter resistance**



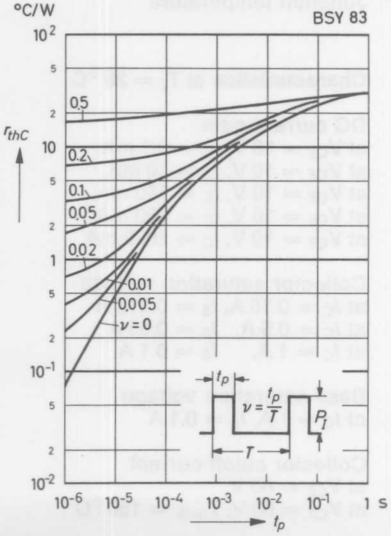

**Admissible power dissipation versus temperature**




**Collector emitter capacitance, Emitter base capacitance versus reverse bias voltage**



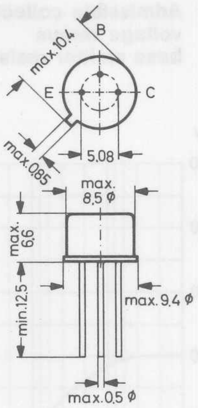

**Pulse thermal resistance versus pulse duration**




– – – – upper limit, valid for 95 % of a lot

# BSY 84

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications
at higher collector current




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

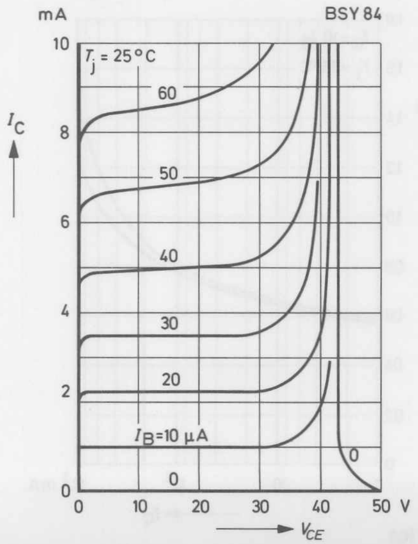
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 80 | V |
| Collector emitter voltage | $V_{CE0}$ | 35 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.9 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 2.8 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 5 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25$ °C

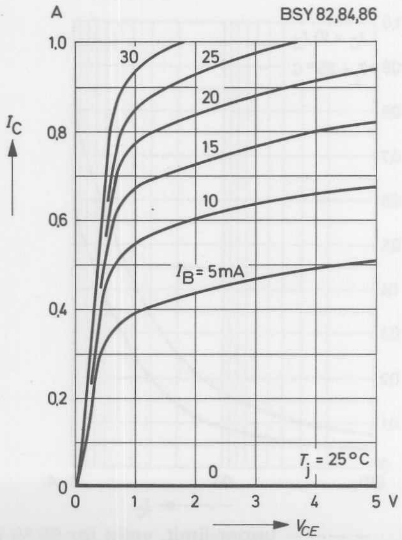
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 60 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 140 (> 75) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 190 (100 . . . 300) | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 120 (> 40) | |
| at $V_{CE} = 10$ V, $I_C = 1000$ mA | $h_{FE}$ | 50 (> 20) | |
| Collector saturation voltage | | | |
| at $I_C = 0.15$ A, $I_B = 0.015$ A | $V_{CE\,sat}$ | < 0.25 | V |
| at $I_C = 0.5$ A, $I_B = 0.05$ A | $V_{CE\,sat}$ | < 0.6 | V |
| at $I_C = 1$ A, $I_B = 0.1$ A | $V_{CE\,sat}$ | < 1 | V |
| Base saturation voltage | | | |
| at $I_C = 1$ A, $I_B = 0.1$ A | $V_{BE\,sat}$ | < 1.8 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 60$ V | $I_{CB0}$ | 0.6 (< 10) | nA |
| at $V_{CB} = 60$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | 0.3 (< 10) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current<br>at $V_{EB} = 3$ V | $I_{EB0}$ | 5 (< 10) | nA |
| Collector base capacitance<br>at $V_{CB0} = 10$ V | $C_{CB0}$ | 8.5 (< 15) | pF |
| Emitter base capacitance<br>at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 50 (< 60) | pF |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 120 | MHz |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{th\,A}$<br>$R_{th\,C}$ | <br>< 194<br>< 35 | <br>°C/W<br>°C/W |

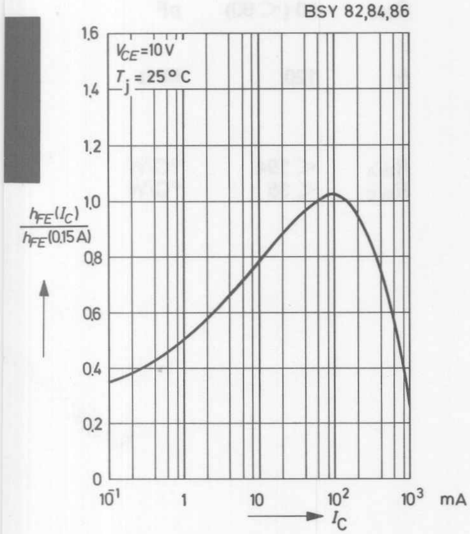
**Common emitter collector characteristics**



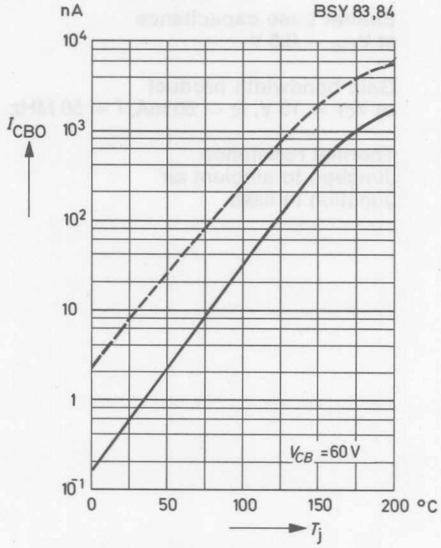

**Common emitter collector characteristics**



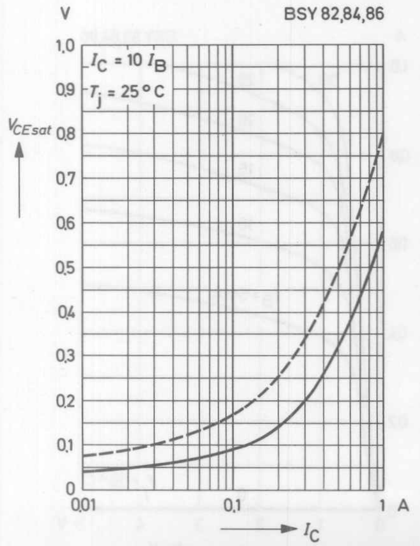
**Relative DC current gain versus collector current**



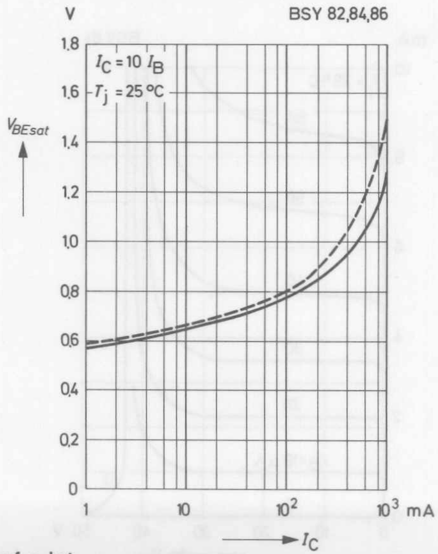

**Collector cutoff current versus junction temperature**




**Collector saturation voltage versus collector current**

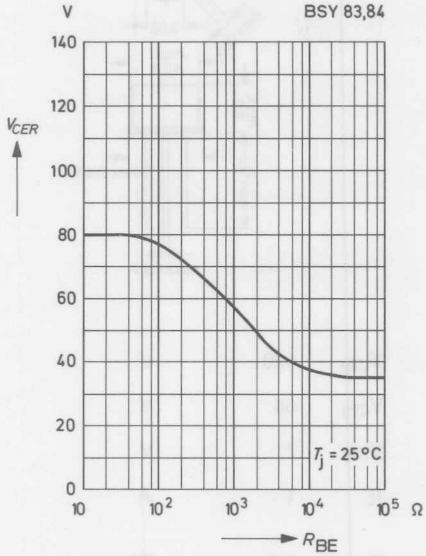



**Base saturation voltage versus collector current**

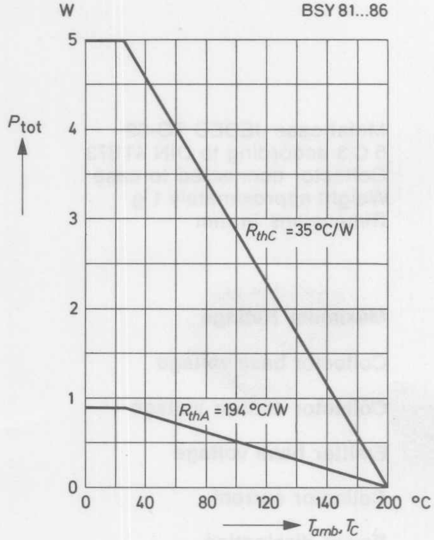



– – – – upper limit, valid for 95 % of a lot

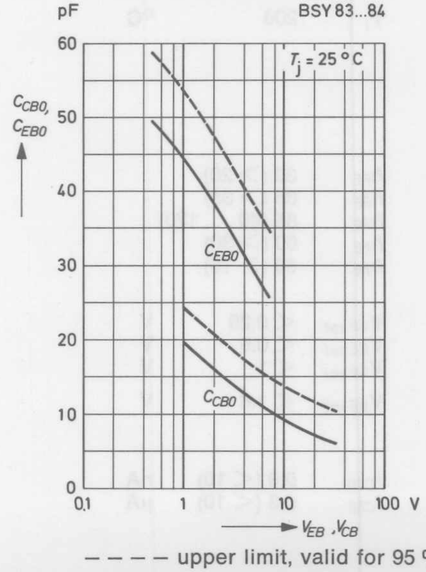
**Admissible collector emitter voltage versus base emitter resistance**



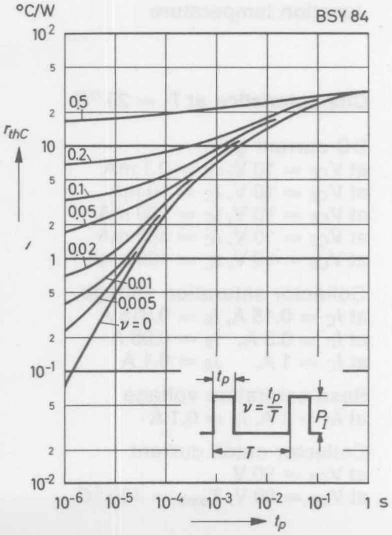

**Admissible power dissipation versus temperature**




**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



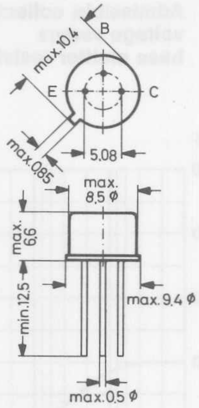

**Pulse thermal resistance versus pulse duration**




– – – – upper limit, valid for 95 % of a lot

# BSY 85 ≈ 2 N 2193 A

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications
at higher collector current




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

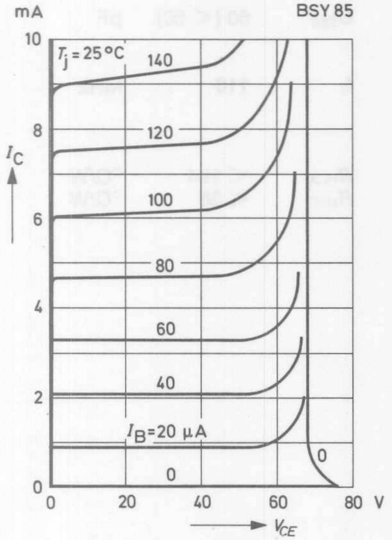
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 120 | V |
| Collector emitter voltage | $V_{CE0}$ | 64 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.9 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 2.8 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 5 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25$ °C

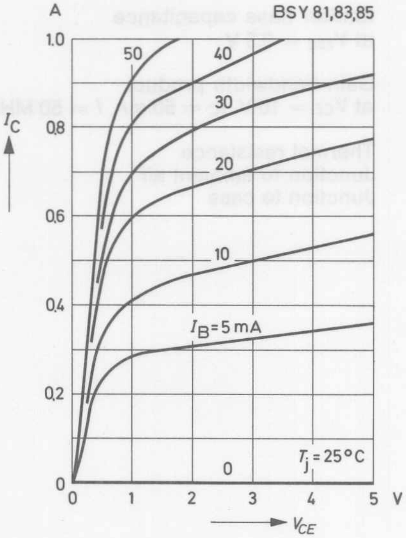
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 30 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 65 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 85 (40 . . . 120) | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 60 (> 30) | |
| at $V_{CE} = 10$ V, $I_C = 1000$ mA | $h_{FE}$ | 30 (> 15) | |
| Collector saturation voltage | | | |
| at $I_C = 0.15$ A, $I_B = 0.015$ A | $V_{CE\,sat}$ | < 0.25 | V |
| at $I_C = 0.5$ A, $I_B = 0.05$ A | $V_{CE\,sat}$ | < 0.6 | V |
| at $I_C = 1$ A, $I_B = 0.1$ A | $V_{CE\,sat}$ | < 1 | V |
| Base saturation voltage at $I_C = 1$ A, $I_B = 0.1$ A | $V_{BE\,sat}$ | < 1.8 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 90$ V | $I_{CB0}$ | 0.6 (< 10) | nA |
| at $V_{CB} = 90$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | 0.3 (< 10) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current<br>at $V_{EB} = 3$ V | $I_{EB0}$ | 5 ($<$ 10) | nA |
| Collector base capacitance<br>at $V_{CB0} = 10$ V | $C_{CB0}$ | 8.5 ($<$ 15) | pF |
| Emitter base capacitance<br>at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 50 ($<$ 60) | pF |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 110 | MHz |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{th\,A}$<br>$R_{th\,C}$ | <br>$<$ 194<br>$<$ 35 | <br>°C/W<br>°C/W |

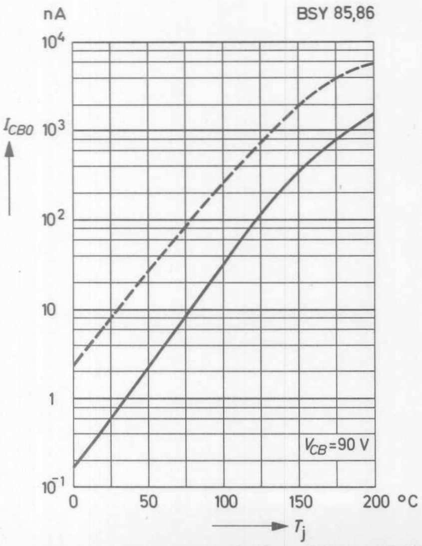
**Common emitter collector characteristics**



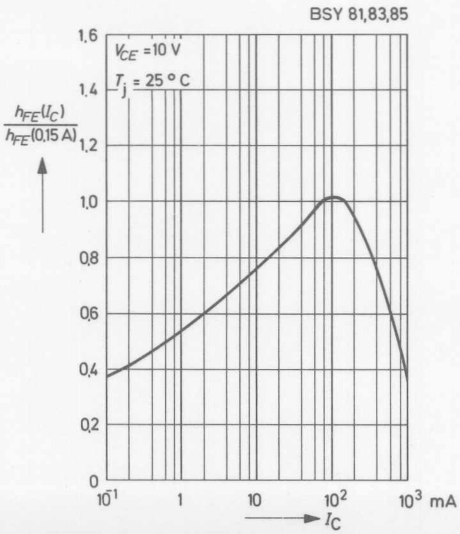

**Common emitter collector characteristics**




**Collector cutoff current versus junction temperature**

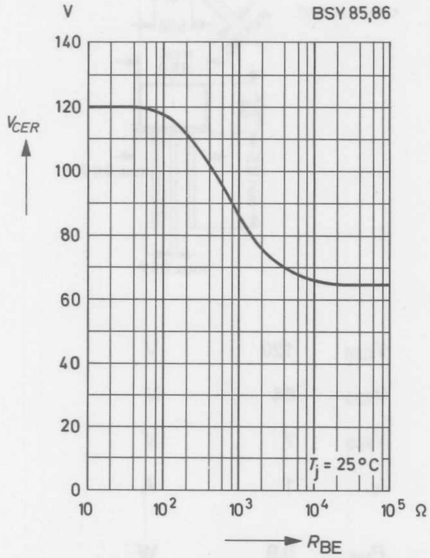



**Relative DC current gain versus collector current**

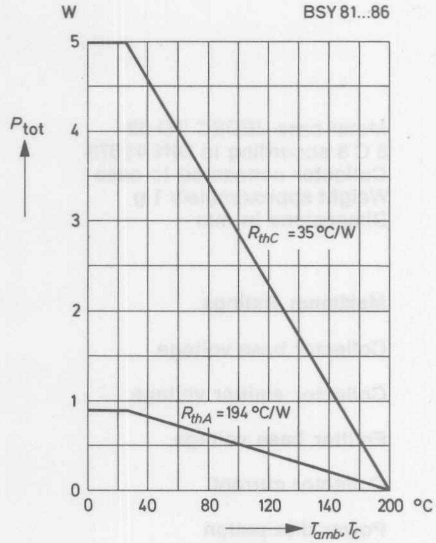



– – – – upper limit, valid for 95 % of a lot

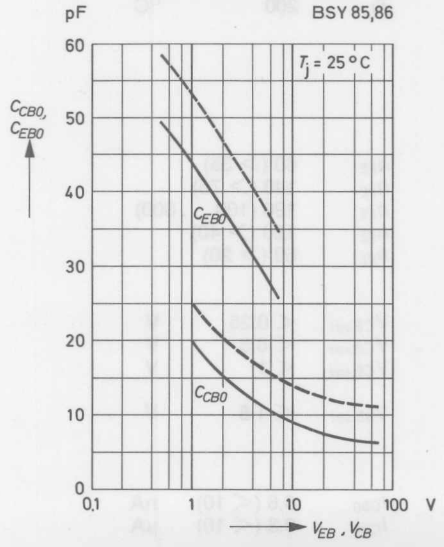
**Admissible collector emitter voltage versus base emitter resistance**



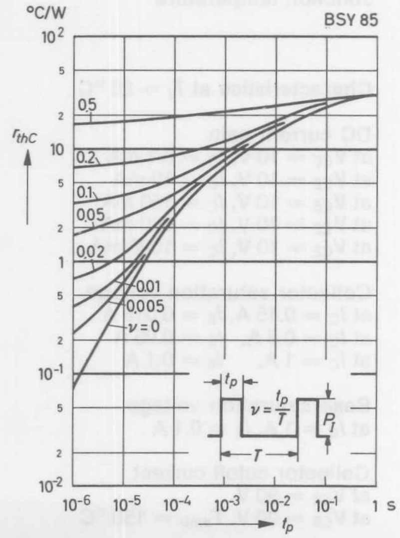

**Admissible power dissipation versus temperature**




**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



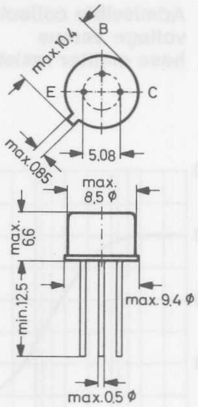

**Pulse thermal resistance versus pulse duration**




– – – – upper limit, valid for 95 % of a lot

# BSY 86

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications
at higher collector current




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

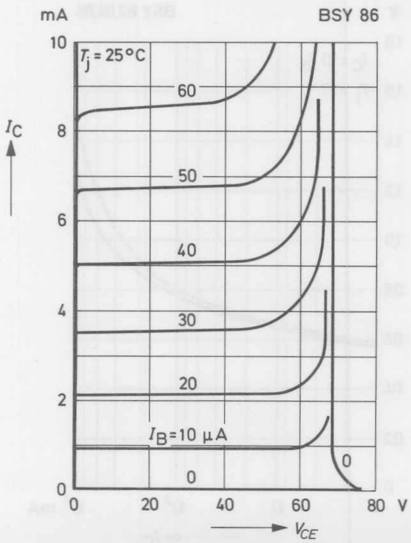
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 120 | V |
| Collector emitter voltage | $V_{CE0}$ | 64 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.9 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 2.8 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 5 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25\ °C$

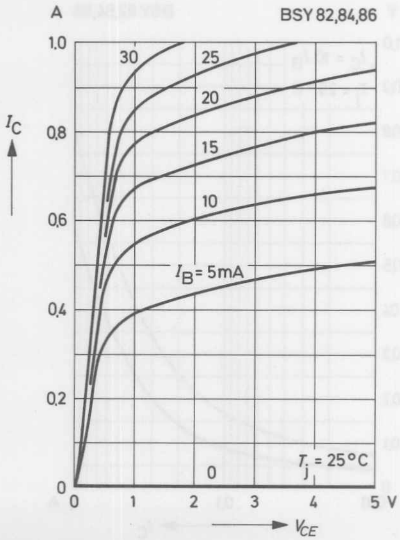
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 60 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 140 (> 75) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 190 (100 . . . 300) | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 120 (> 40) | |
| at $V_{CE} = 10$ V, $I_C = 1000$ mA | $h_{FE}$ | 50 (> 20) | |
| Collector saturation voltage | | | |
| at $I_C = 0.15$ A, $I_B = 0.015$ A | $V_{CE\,sat}$ | < 0.25 | V |
| at $I_C = 0.5$ A, $I_B = 0.05$ A | $V_{CE\,sat}$ | < 0.6 | V |
| at $I_C = 1$ A, $I_B = 0.1$ A | $V_{CE\,sat}$ | < 1 | V |
| Base saturation voltage at $I_C = 1$ A, $I_B = 0.1$ A | $V_{BE\,sat}$ | < 1.8 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 90$ V | $I_{CB0}$ | 0.6 (< 10) | nA |
| at $V_{CB} = 90$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | 0.3 (< 10) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current at $V_{EB} = 3$ V | $I_{EBO}$ | 5 (< 10) | nA |
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 8.5 (< 15) | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 50 (< 60) | pF |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 130 | MHz |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 194 | °C/W |
| Junction to case | $R_{th\,C}$ | < 35 | °C/W |

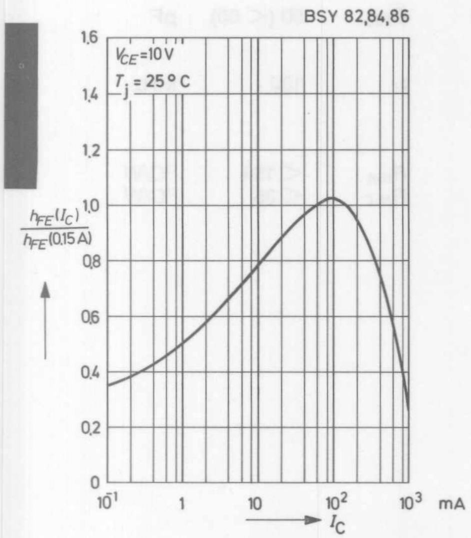
**Common emitter collector characteristics**



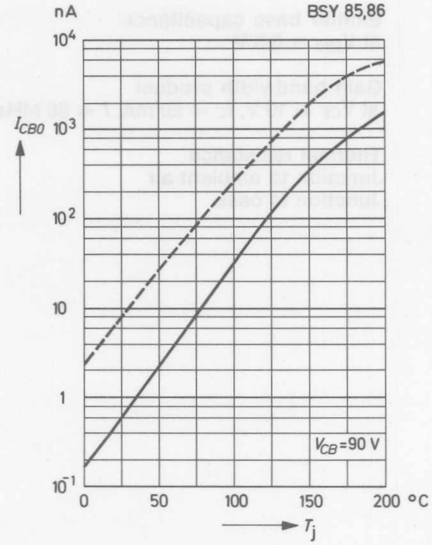

**Common emitter collector characteristics**



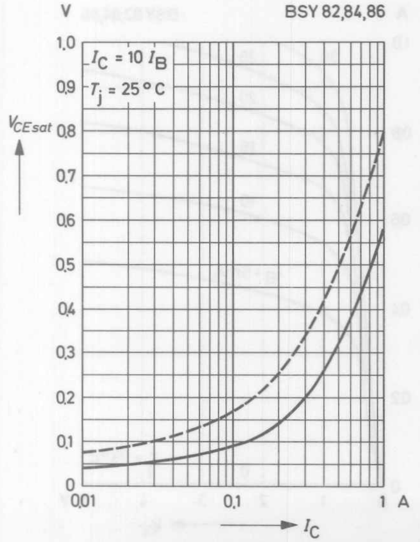
## Relative DC current gain versus collector current



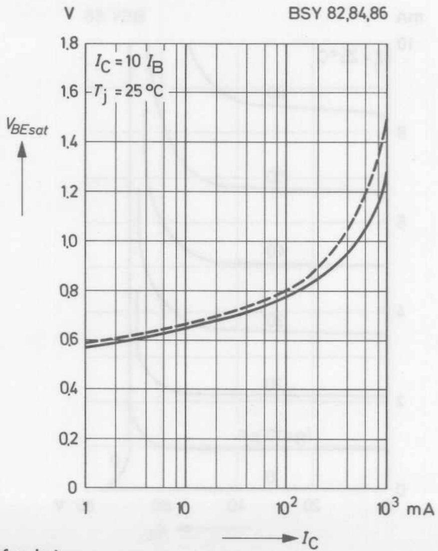

## Collector cutoff current versus junction temperature




## Collector saturation voltage versus collector current

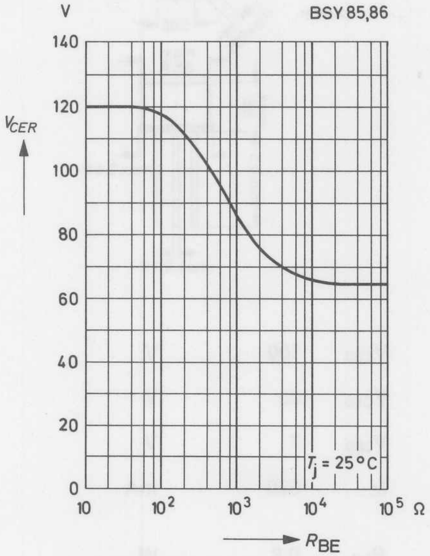



## Base saturation voltage versus collector current

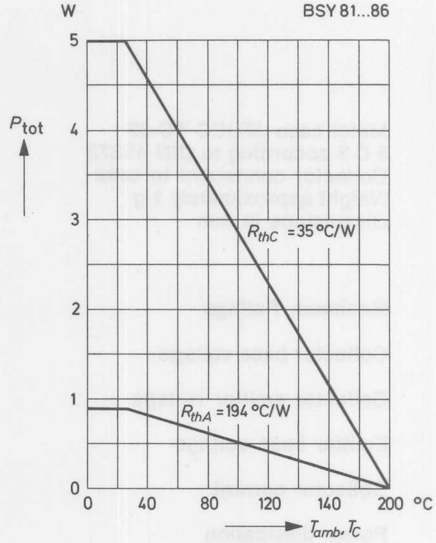



– – – – upper limit, valid for 95 % of a lot

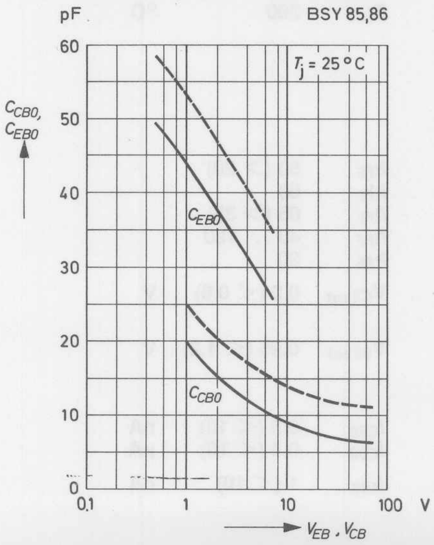
**Admissible collector emitter voltage versus base emitter resistance**



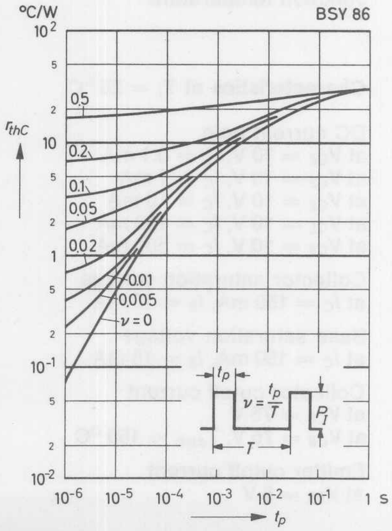

**Admissible power dissipation versus temperature**




**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



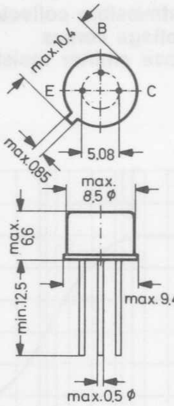

**Pulse thermal resistance versus pulse duration**




– – – – upper limit, valid for 95 % of a lot

# BSY 87 ≈ 2 N 1889

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 100 | V |
| Collector emitter voltage | $V_{CE0}$ | 60 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb} =$ 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 50 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | 60 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 65 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 . . . 120 | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 20 | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 0.2 (< 0.6) | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB} = 75$ V | $I_{CB0}$ | 0.5 (< 10) | nA |
| at $V_{CB} = 75$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | 0.4 (< 10) | µA |
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EB0}$ | 1 (< 10) | nA |

| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 5.5 (< 10) | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 23 (< 33) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 58 | °C/W |

**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

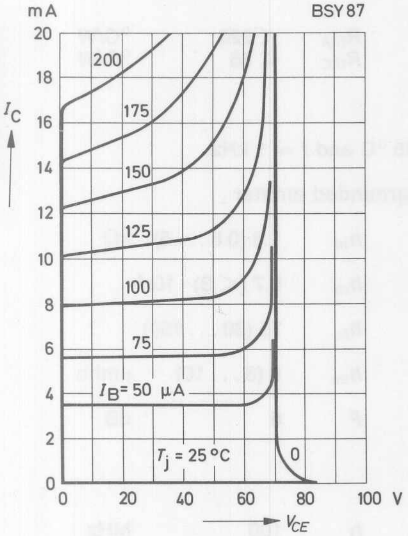
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 1.8 (0.8 . . . 5) | kΩ |
| Reserve voltage transfer ratio | $h_{re}$ | $0.7\ (< 3) \cdot 10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 75 (30 . . . 150) | |
| Output admittance | $h_{oe}$ | 6 (3 . . . 10) | μmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 100 | MHz |

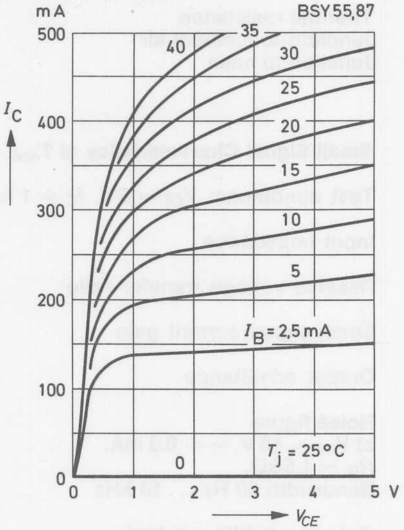
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

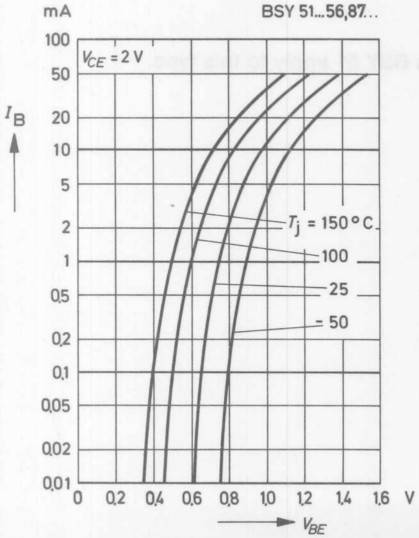
### Common emitter collector characteristics



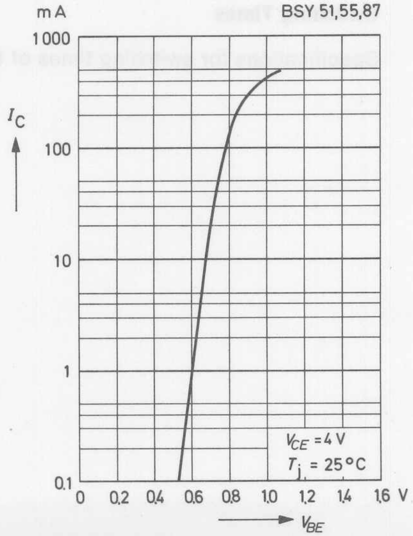

### Common emitter collector characteristics



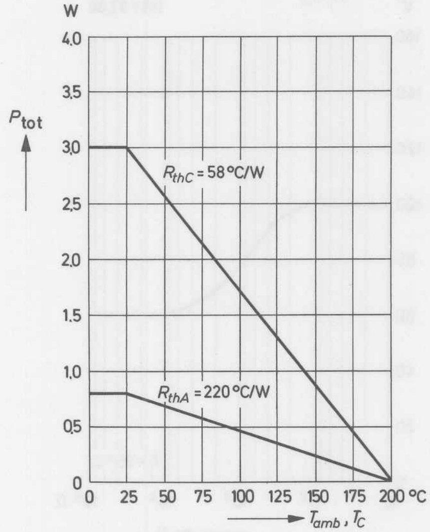

### Common emitter input characteristics



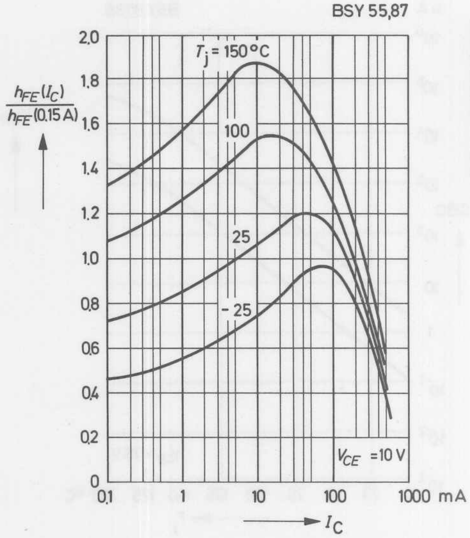

### Collector current versus base emitter voltage



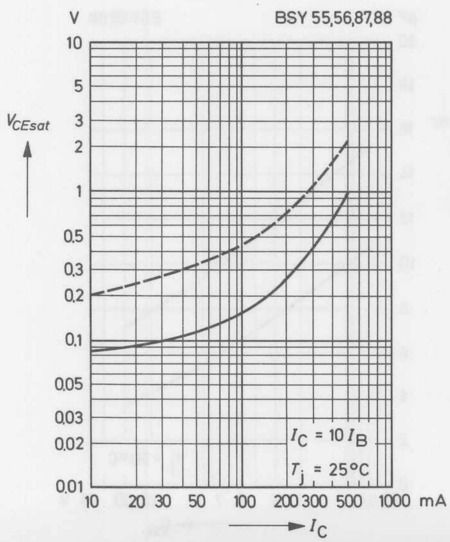
**Admissible power dissipation versus temperature**



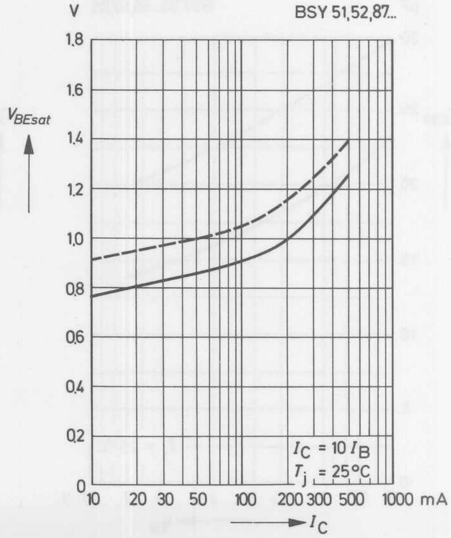

**Relative DC current gain versus collector current**




**Collector saturation voltage versus collector current**

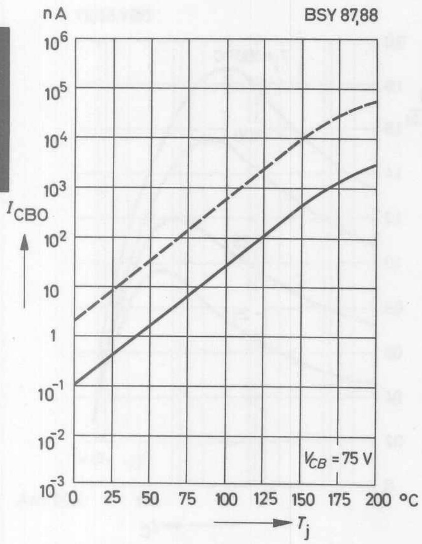



**Base saturation voltage versus collector current**

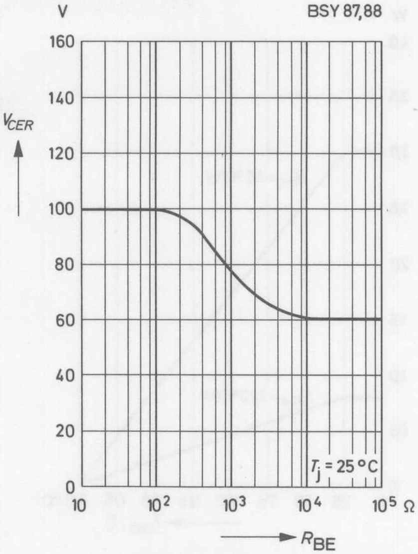



– – – – upper limit, valid for 95 % of a lot

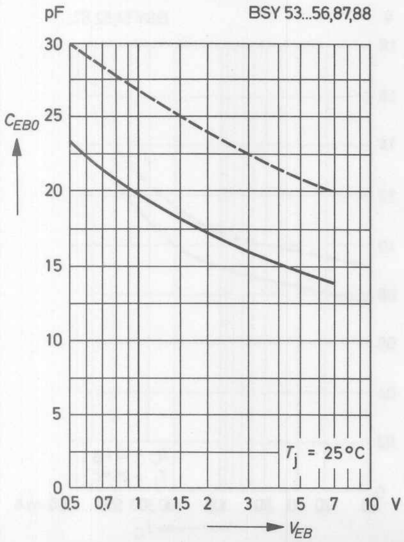
**Collector cutoff current versus junction temperature**



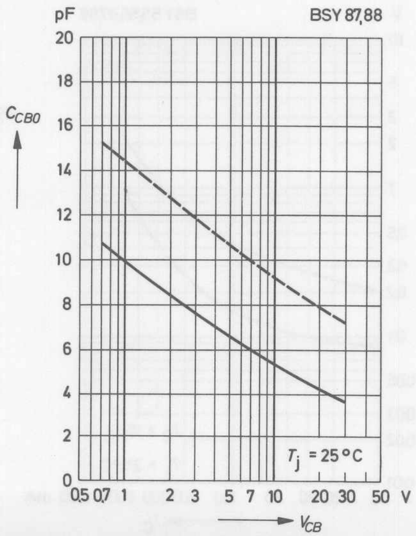

**Admissible collector emitter voltage versus base emitter resistance**




**Emitter base capacitance versus emitter base voltage**

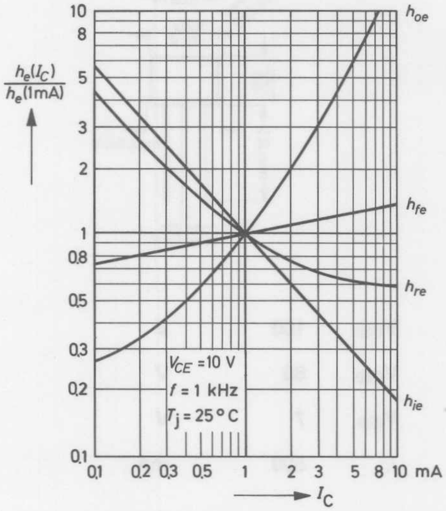



**Collector base capacitance versus collector base voltage**

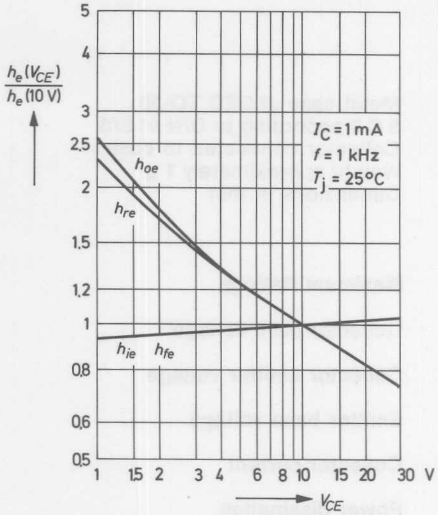



– – – – upper limit, valid for 95 % of a lot

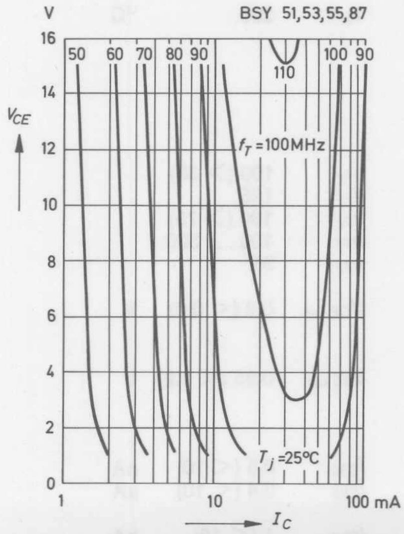
**Relative $h$-parameters versus collector current**



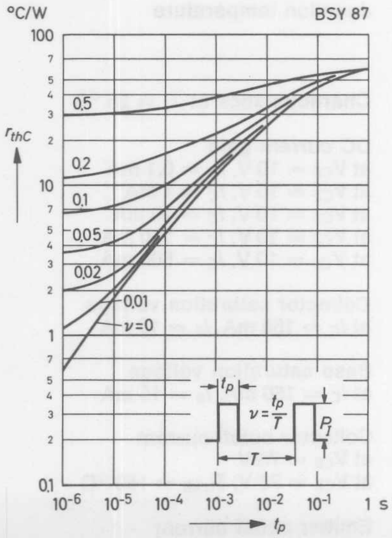

**Relative $h$-parameters versus collector emitter voltage**




**Contours of constant gain bandwidth product**

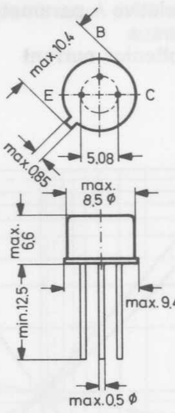



**Pulse thermal resistance versus pulse duration**



# BSY 88 ≈ 2 N 1890

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 100 | V |
| Collector emitter voltage | $V_{CEO}$ | 60 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 100 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | 125 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 180 (> 75) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 100 . . . 300 | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 35 | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 0.2 (< 0.6) | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB} = 75$ V | $I_{CBO}$ | 0.5 (< 10) | nA |
| at $V_{CB} = 75$ V, $T_{amb} = 150$ °C | $I_{CBO}$ | 0.4 (< 10) | µA |
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EBO}$ | 1 (< 10) | nA |

| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CBO} = 10$ V | $C_{CBO}$ | 5.5 (< 10) | pF |
| Emitter base capacitance at $V_{EBO} = 0.5$ V | $C_{EBO}$ | 23 (< 33) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 58 | °C/W |

**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

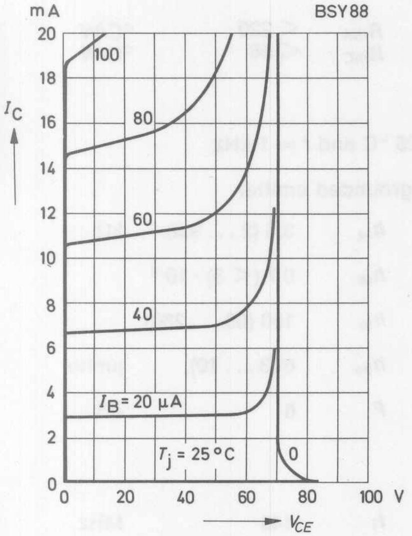
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 3.5 (2 . . . 9.5) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | 0.7 (< 3) · $10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 150 (60 . . . 280) | |
| Output admittance | $h_{oe}$ | 6 (3 . . . 10) | µmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 6 | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 145 | MHz |

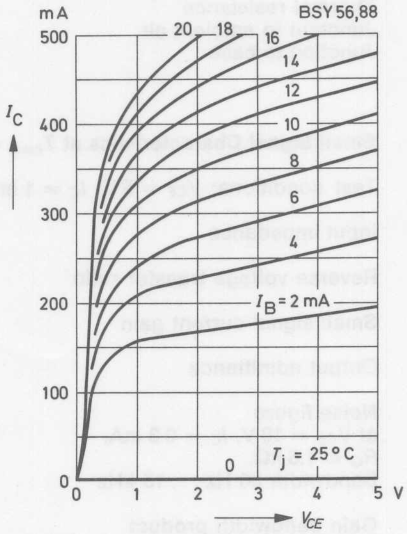
**Switching Times**

Specifications for switching times of type BSY 51 apply to this type.

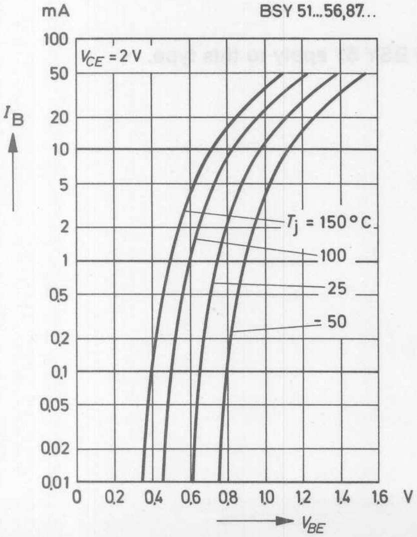
**Common emitter collector characteristics**



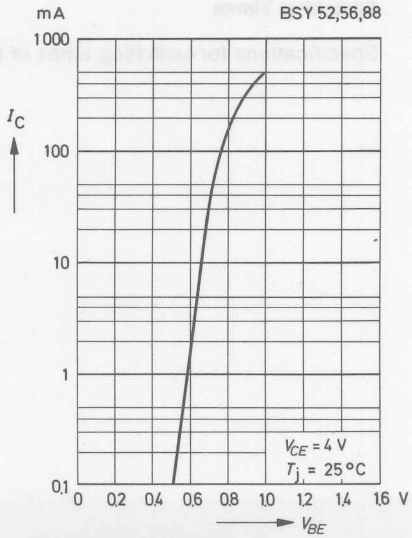

**Common emitter collector characteristics**



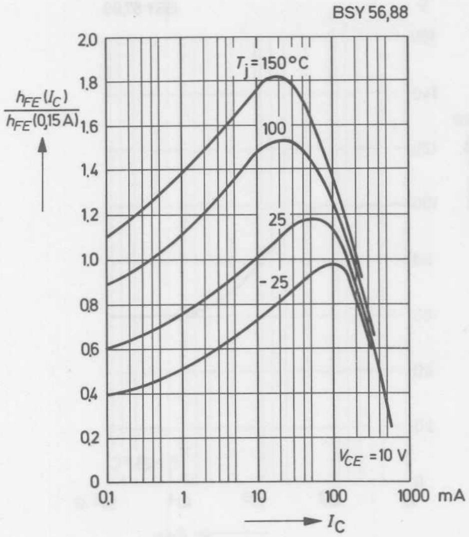

**Common emitter input characteristics**



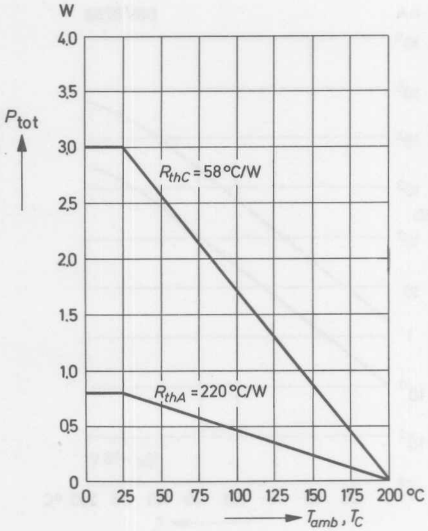

**Collector current versus base emitter voltage**



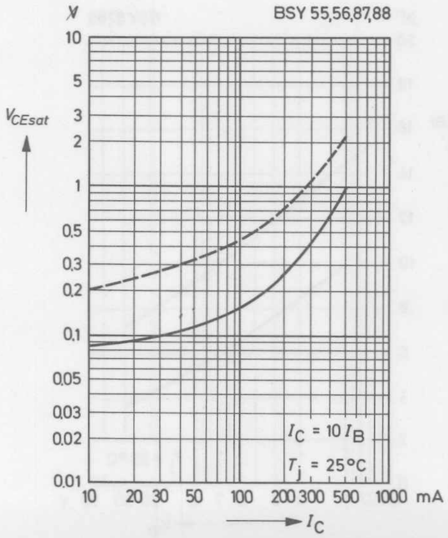
**Relative DC current gain versus collector current**



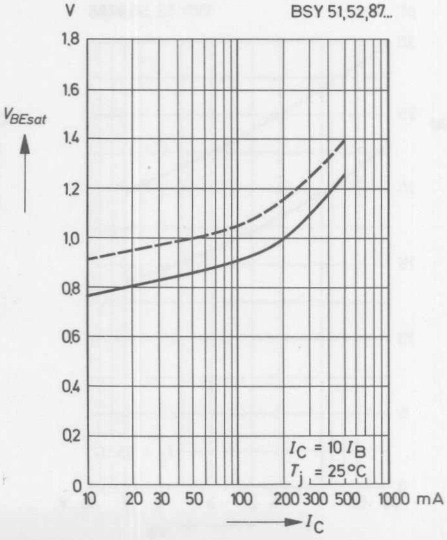

**Admissible power dissipation versus temperature**




**Collector saturation voltage versus collector current**

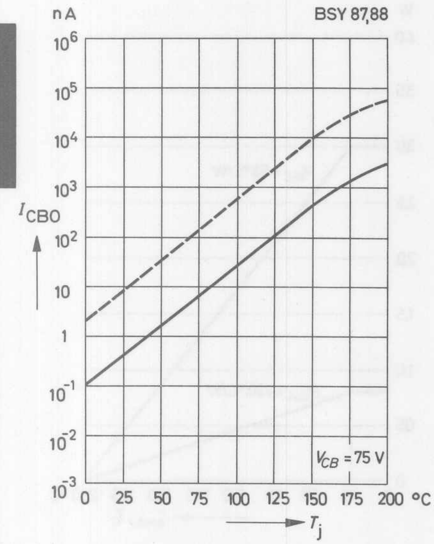



**Base saturation voltage versus collector current**

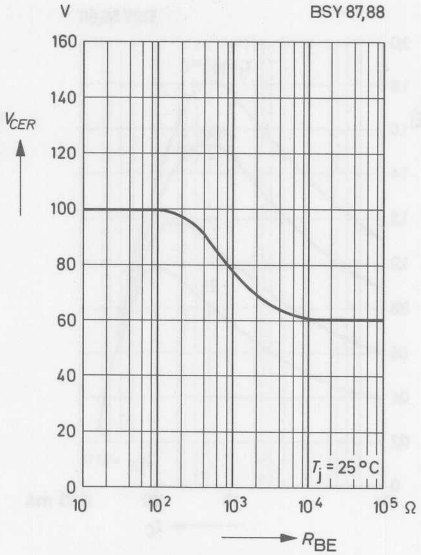



– – – – upper limit, valid for 95 % of a lot

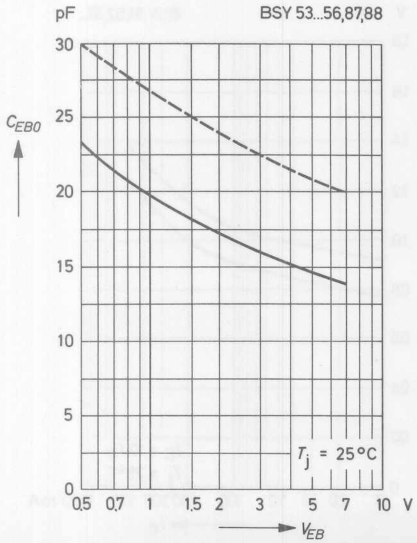
**Collector cutoff current versus junction temperature**



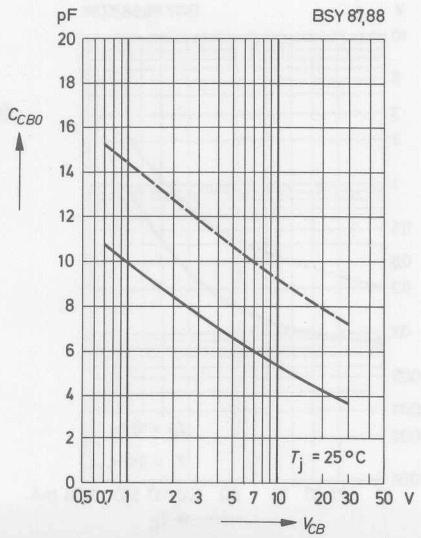

**Admissible collector emitter voltage versus base emitter resistor**




**Emitter base capacitance versus emitter base voltage**

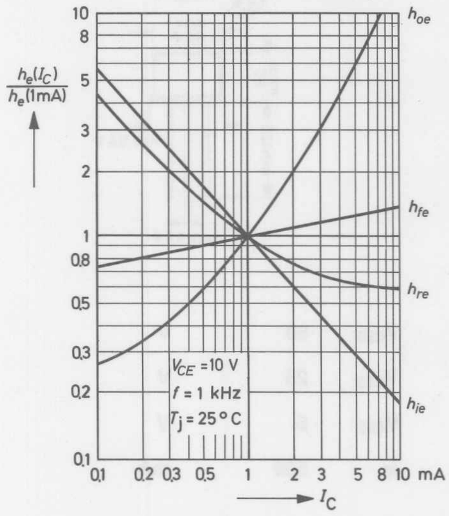



**Collector base capacitance versus collector base voltage**

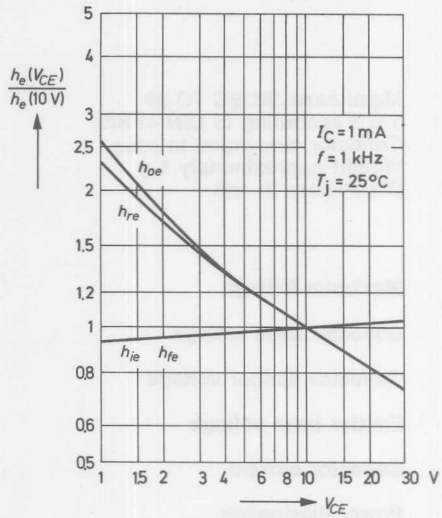



– – – – upper limit, valid for 95 % of a lot

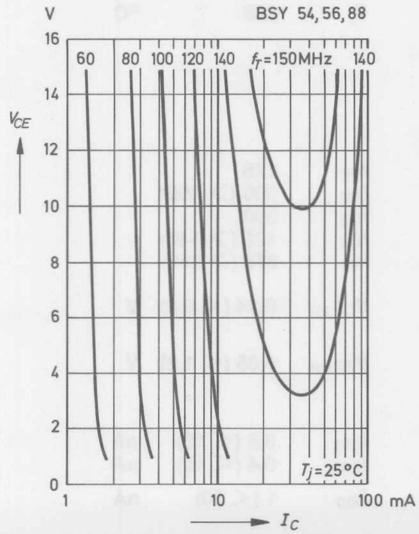
**Relative *h*-parameters versus collector current**



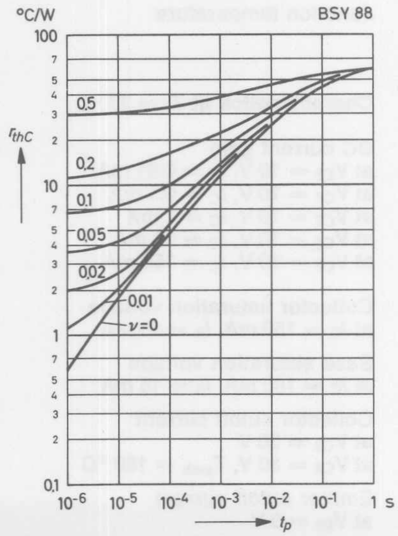

**Relative *h*-parameters versus collector emitter voltage**




**Contours of constant gain bandwidth product**

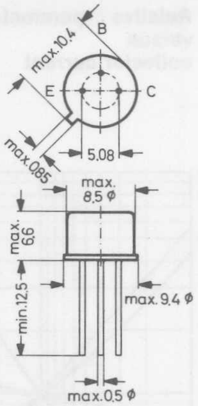



**Pulse thermal resistance versus pulse duration**



# BSY 90

**NPN Silicon Epitaxial Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 60 | V |
| Collector emitter voltage | $V_{CEO}$ | 25 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.8 | W |
| at $T_C$ = 100 °C | $P_{tot}$ | 1.7 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |

**Characteristics** at $T_j$ = 25 °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE}$ = 10 V, $I_C$ = 0.01 mA | $h_{FE}$ | 125 | |
| at $V_{CE}$ = 10 V, $I_C$ = 0.1 mA | $h_{FE}$ | 200 (> 100) | |
| at $V_{CE}$ = 10 V, $I_C$ = 1 mA | $h_{FE}$ | 300 | |
| at $V_{CE}$ = 10 V, $I_C$ = 10 mA | $h_{FE}$ | 425 (> 140) | |
| at $V_{CE}$ = 10 V, $I_C$ = 150 mA | $h_{FE}$ | 375 (> 250) | |
| Collector saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{CE\,sat}$ | 0.14 (< 0.8) | V |
| Base saturation voltage at $I_C$ = 150 mA, $I_B$ = 15 mA | $V_{BE\,sat}$ | 0.95 (< 1.2) | V |
| Collector cutoff current | | | |
| at $V_{CB}$ = 30 V | $I_{CBO}$ | 0.5 (< 10) | nA |
| at $V_{CB}$ = 30 V, $T_{amb}$ = 150 °C | $I_{CBO}$ | 0.4 (< 10) | µA |
| Emitter cutoff current at $V_{EB}$ = 3 V | $I_{EBO}$ | 1 (< 50) | nA |

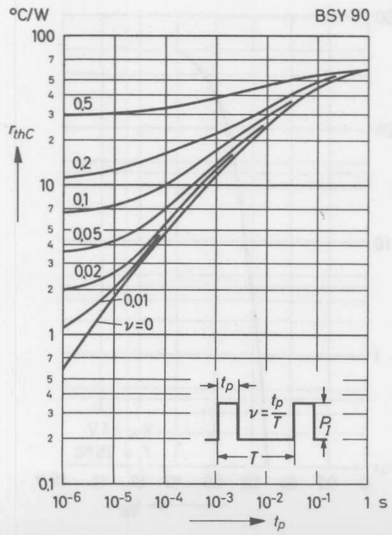
| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CB0} = 10$ V | $C_{CB0}$ | 7.5 (< 10) | pF |
| Emitter base capacitance at $V_{EB0} = 0.5$ V | $C_{EB0}$ | 23 (< 33) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 58 | °C/W |

**Small Signal Characteristics** at $T_{amb} = 25$ °C and $f = 1$ kHz

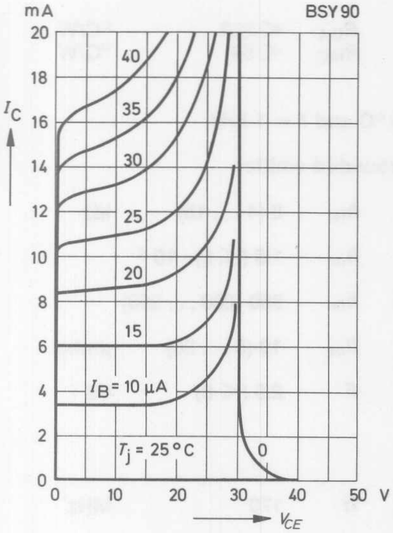
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, grounded emitter

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 8 (4 . . . 15) | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | 1.5 (< 5) · $10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 350 (200 . . . 550) | |
| Output admittance | $h_{oe}$ | 10 (5 . . . 25) | µmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 1.5$ kΩ, Bandwidth 30 Hz . . . 15 kHz | $F$ | 2.5 (< 8) | dB |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 170 | MHz |

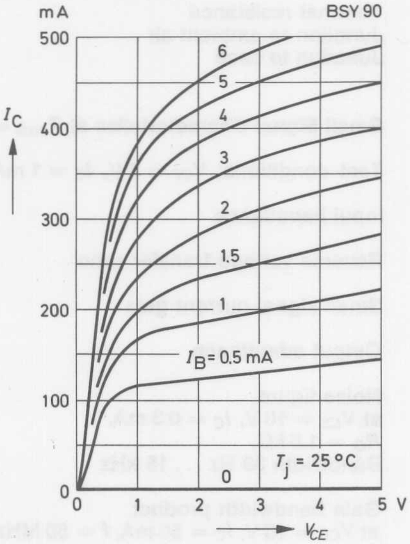
**Pulse thermal resistance versus pulse duration**



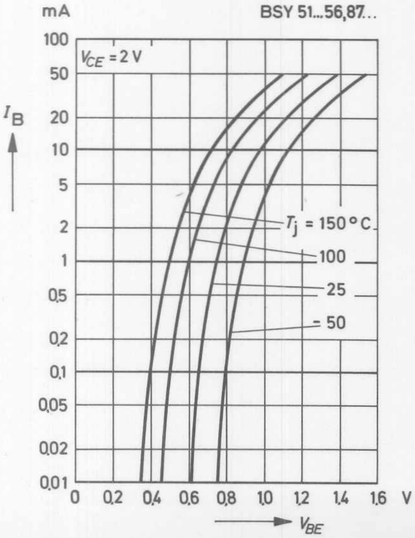
**Common emitter collector characteristics**



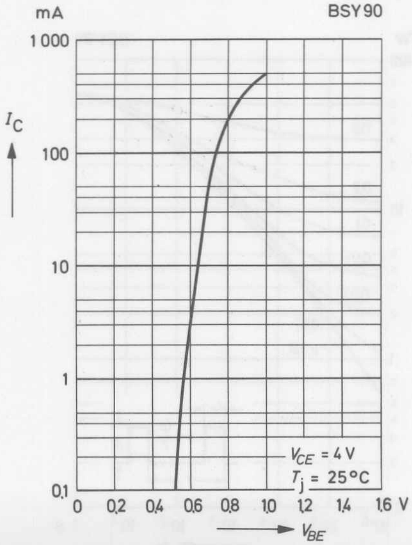

**Common emitter collector characteristics**



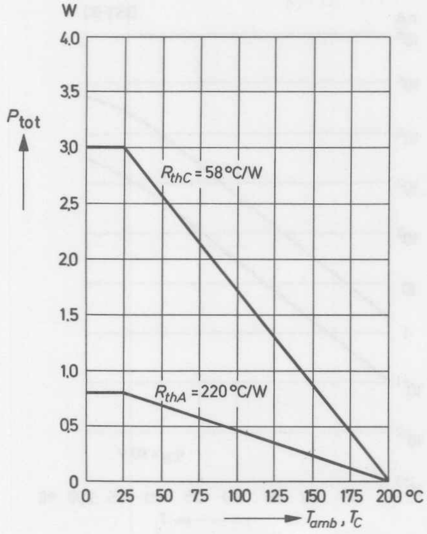

**Common emitter input characteristics**



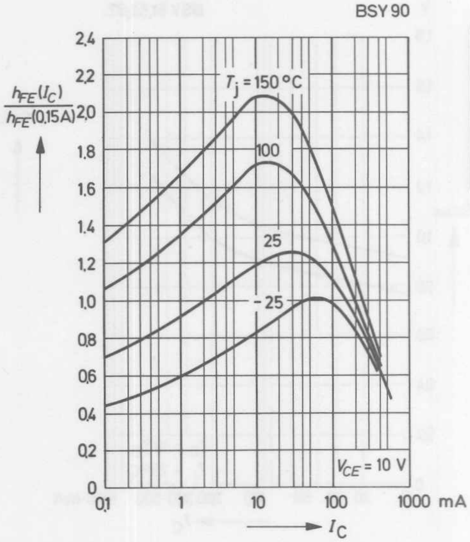

**Collector current versus base emitter voltage**



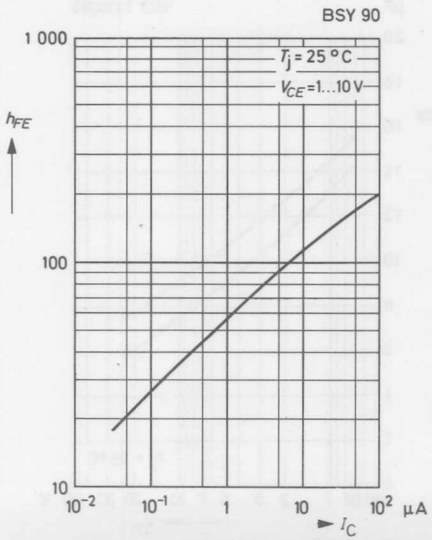
**Admissible power dissipation versus temperature**



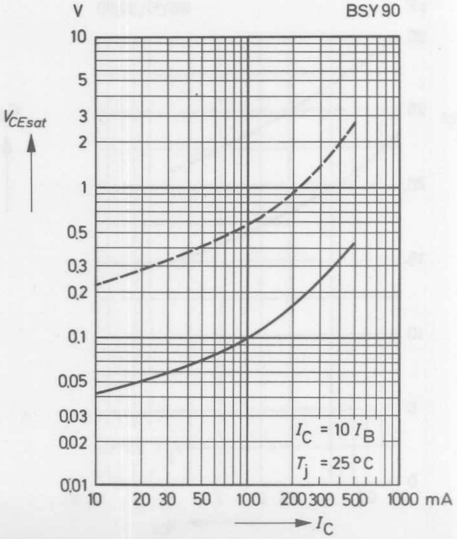

**Relative DC current gain versus collector current**




**DC current gain versus small collector current**

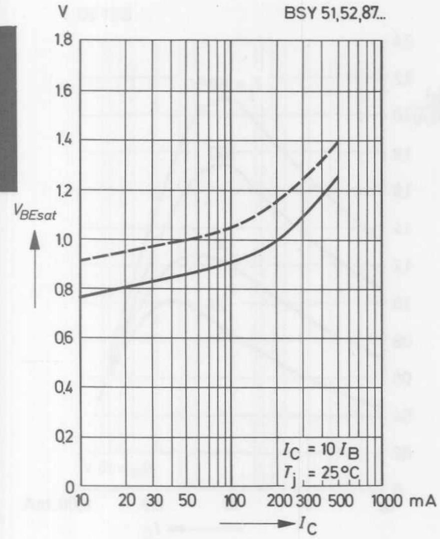



**Collector saturation voltage versus collector current**

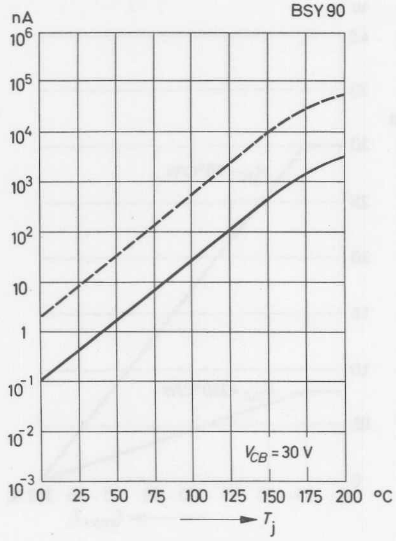



– – – – upper limit, valid for 95 % of a lot

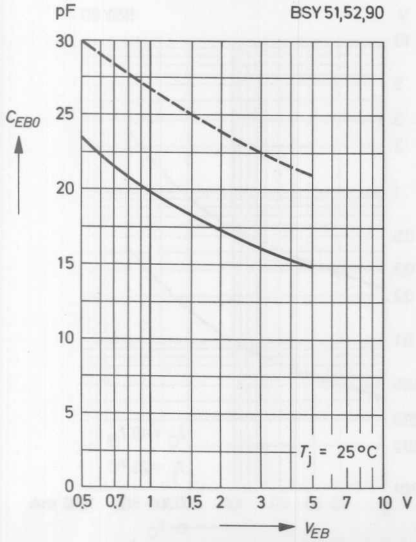
**Base saturation voltage versus collector current**



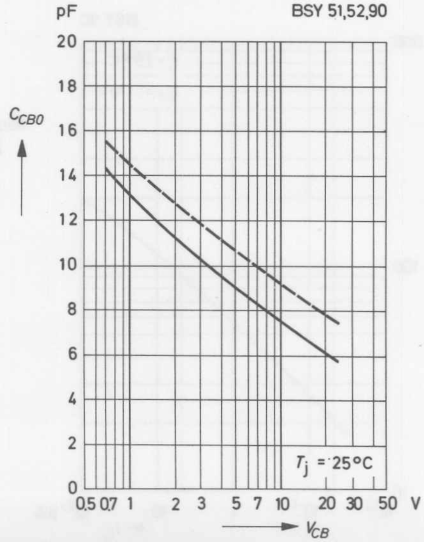

**Collector cutoff current versus junction temperature**




**Emitter base capacitance versus emitter base voltage**

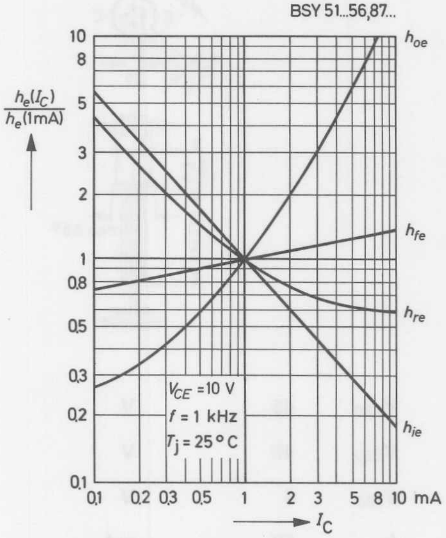



**Collector base capacitance versus collector base voltage**

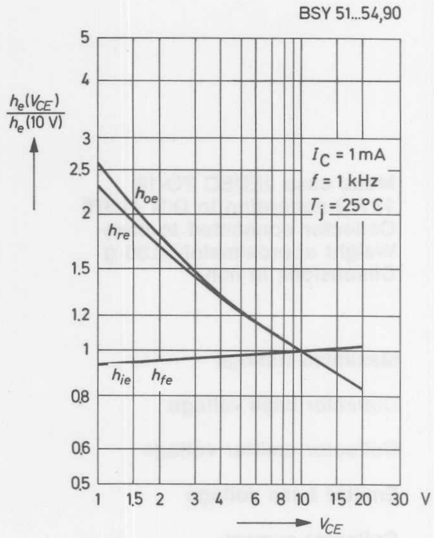



– – – – upper limit, valid for 95 % of a lot

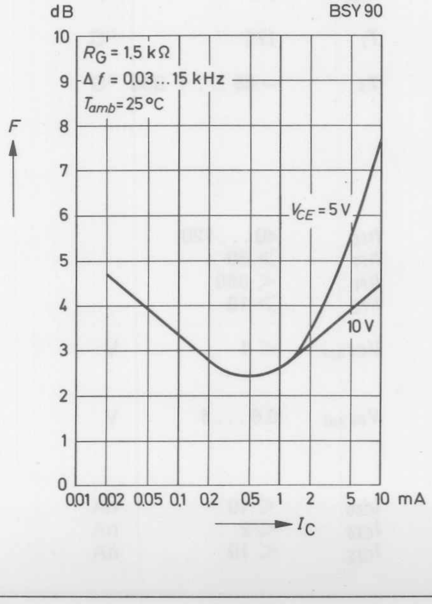
**Relative *h*-parameters versus collector current**



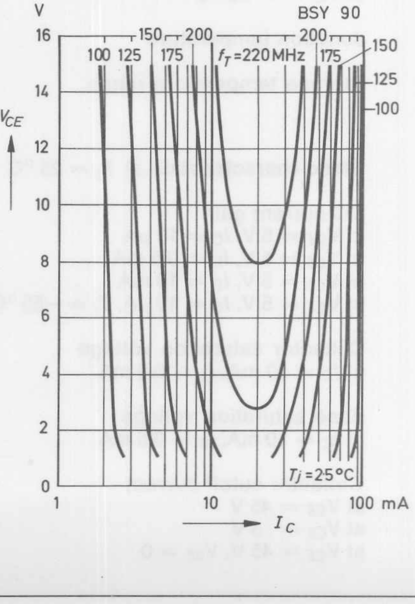

**Relative *h*-parameters versus collector emitter voltage**




**Noise figure versus collector current**

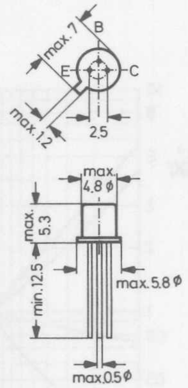



**Contours of constant gain bandwidth product**



# 2 N 929

**NPN Silicon Planar Transistor**
for use in high-performance, low-level, low-noise amplifier circuits from audio through high frequency ranges




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 45 | V |
| Collector emitter voltage | $V_{CE0}$ | 45 | V |
| Emitter base voltage | $V_{EB0}$ | 5 | V |
| Collector current | $I_C$ | 30 | mA |
| Power dissipation | | | |
| at $T_{amb}$ = 25 °C | $P_{tot}$ | 0.3 | W |
| at $T_C$ = 25 °C | $P_{tot}$ | 0.6 | W |
| Junction temperature | $T_j$ | 175 | °C |
| Storage temperature range | $T_S$ | – 65 . . . + 300 | °C |

**Static characteristics** at $T_j = 25$ °C

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 5$ V, $I_C = 10$ μA | $h_{FE}$ | 40 . . . 120 | |
| at $V_{CE} = 5$ V, $I_C = 0.5$ mA | $h_{FE}$ | $> 60$ | |
| at $V_{CE} = 5$ V, $I_C = 10$ mA | $h_{FE}$ | $< 350$ | |
| at $V_{CE} = 5$ V, $I_C = 10$ μA, $T_j = -55$ °C | $h_{FE}$ | $> 10$ | |
| Collector saturation voltage at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{CE\,sat}$ | $< 1$ | V |
| Base saturation voltage at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{BE\,sat}$ | 0.6 . . . 1 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 45$ V | $I_{CBO}$ | $< 10$ | nA |
| at $V_{CE} = 5$ V | $I_{CEO}$ | $< 2$ | nA |
| at $V_{CE} = 45$ V, $V_{BE} = 0$ | $I_{CES}$ | $< 10$ | nA |

| | | | |
|---|---|---|---|
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EBO}$ | $< 10$ | nA |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 500$ | °C/W |
| Junction to case | $R_{thC}$ | $< 250$ | °C/W |

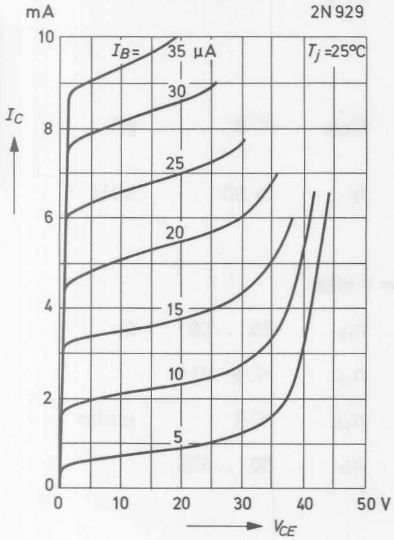
**Dynamic characteristics** at $T_{amb} = 25$ °C

| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CB} = 5$ V, $f = 1$ MHz | $C_{CBO}$ | $< 8$ | pF |
| Gain bandwidth product at $V_{CE} = 5$ V, $I_C = 0.5$ mA | $f_T$ | $> 30$ | MHz |

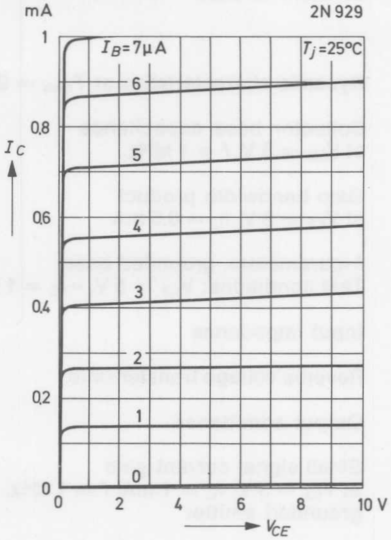
*h*-parameters, grounded base
Test conditions: $V_{CB} = 5$ V, $-I_E = 1$ mA, $f = 1$ kHz

| | | | |
|---|---|---|---|
| Input impedance | $h_{ib}$ | 25 . . . 32 | Ω |
| Reverse voltage transfer ratio | $h_{rb}$ | $< 6 \cdot 10^{-4}$ | |
| Output admittance | $h_{ob}$ | $< 1$ | μmho |
| Small signal current gain at $V_{CE} = 5$ V, $I_C = 1$ mA, $f = 1$ kHz, grounded emitter | $h_{fe}$ | 60 . . . 350 | |
| Noise figure at $V_{CE} = 5$ V, $I_C = 10$ μA, $R_G = 10$ kΩ, $f = 10$ Hz . . . 15 kHz | $F$ | $< 4$ | dB |

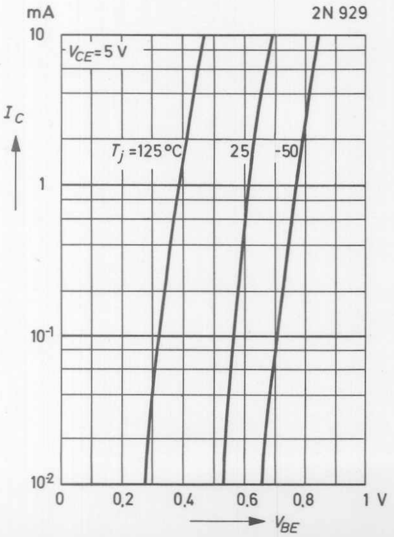
**Common emitter collector characteristics**



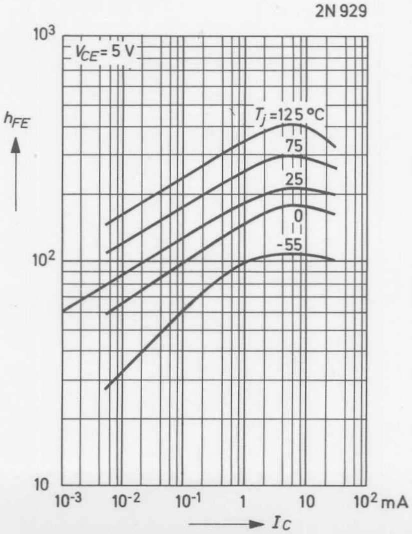

**Common emitter collector characteristics**



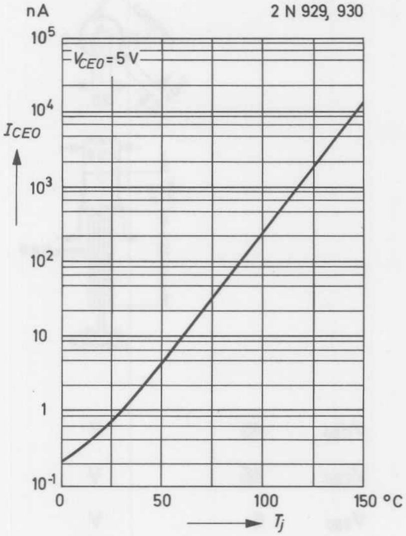

**Collector current versus base emitter voltage**



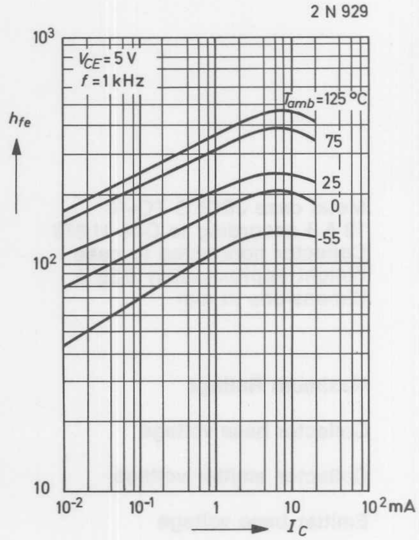

**DC current gain versus collector current**



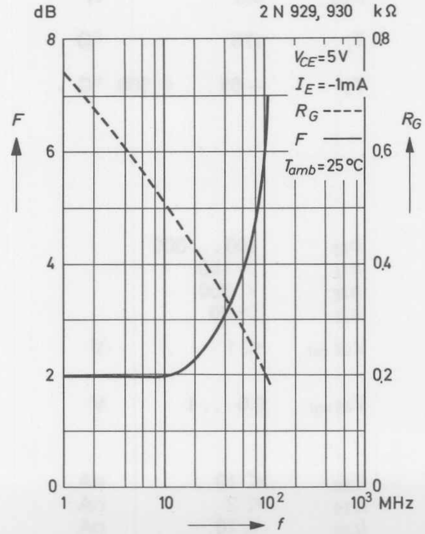
**Collector cutoff current versus junction temperature**



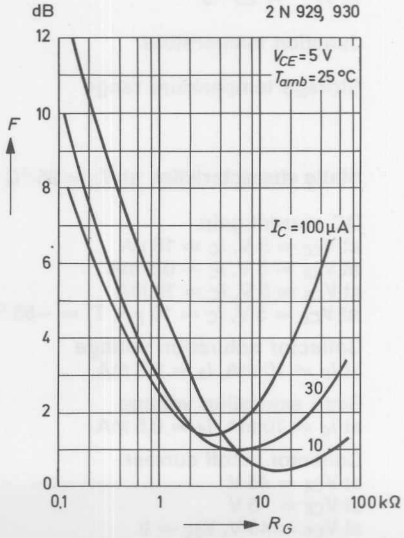

**Small signal current gain versus collector current**




**Noise figure versus frequency**

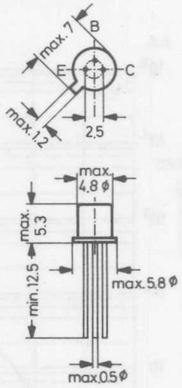



**Noise figure versus generator resistance**



# 2 N 930

**NPN Silicon Planar Transistor**
for use in high-performance, low-level, low-noise amplifier circuits from audio through high frequency ranges




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 45 | V |
| Collector emitter voltage | $V_{CE0}$ | 45 | V |
| Emitter base voltage | $V_{EB0}$ | 5 | V |
| Collector current | $I_C$ | 30 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.3 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 0.6 | W |
| Junction temperature | $T_j$ | 175 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +300$ | °C |

**Static characteristics** at $T_j = 25\ °C$

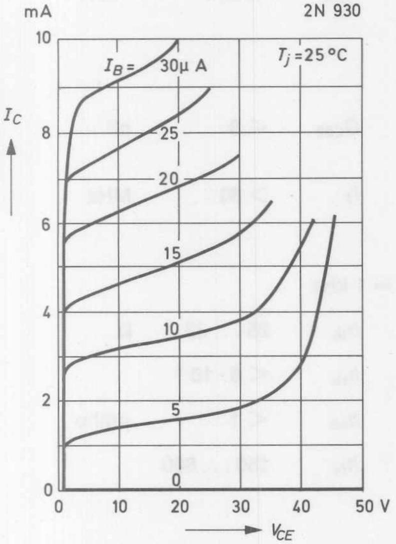
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 5$ V, $I_C = 10\ \mu A$ | $h_{FE}$ | $100 \ldots 300$ | |
| at $V_{CE} = 5$ V, $I_C = 0.5$ mA | $h_{FE}$ | $> 150$ | |
| at $V_{CE} = 5$ V, $I_C = 10$ mA | $h_{FE}$ | $< 600$ | |
| at $V_{CE} = 5$ V, $I_C = 10\ \mu A$, $T_j = -55\ °C$ | $h_{FE}$ | $> 20$ | |
| Collector saturation voltage at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{CE\,sat}$ | $< 1$ | V |
| Base saturation voltage at $I_C = 10$ mA, $I_B = 0.5$ mA | $V_{BE\,sat}$ | $0.6 \ldots 1$ | V |
| Collector cutoff current | | | |
| at $V_{CB} = 45$ V | $I_{CB0}$ | $< 10$ | nA |
| at $V_{CE} = 5$ V | $I_{CE0}$ | $< 2$ | nA |
| at $V_{CE} = 45$ V, $V_{BE} = 0$ | $I_{CES}$ | $< 10$ | nA |

| | | | |
|---|---|---|---|
| Emitter cutoff current<br>at $V_{EB} = 5$ V | $I_{EB0}$ | $< 10$ | nA |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{thA}$<br>$R_{thC}$ | <br>$< 500$<br>$< 250$ | <br>°C/W<br>°C/W |

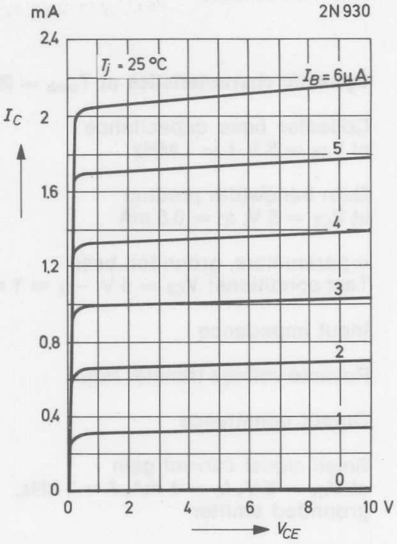
**Dynamic characteristics** at $T_{amb} = 25$ °C

| | | | |
|---|---|---|---|
| Collector base capacitance<br>at $V_{CB} = 5$ V, $f = 1$ MHz | $C_{CB0}$ | $< 8$ | pF |
| Gain bandwidth product<br>at $V_{CE} = 5$ V, $I_C = 0.5$ mA | $f_T$ | $> 30$ | MHz |
| *h*-parameters, grounded base<br>Test conditions: $V_{CB} = 5$ V, $-I_E = 1$ mA, $f = 1$ kHz | | | |
| Input impedance | $h_{ib}$ | 25 . . . 32 | Ω |
| Reverse voltage transfer ratio | $h_{rb}$ | $< 6 \cdot 10^{-4}$ | |
| Output admittance | $h_{ob}$ | $< 1$ | µmho |
| Small signal current gain<br>at $V_{CE} = 5$ V, $I_C = 1$ mA, $f = 1$ kHz,<br>grounded emitter | $h_{fe}$ | 150 . . . 600 | |
| Noise figure<br>at $V_{CE} = 5$ V, $I_C = 10$ µA,<br>$R_G = 10$ kΩ, $f = 10$ Hz . . . 15 kHz | $F$ | $< 3$ | dB |

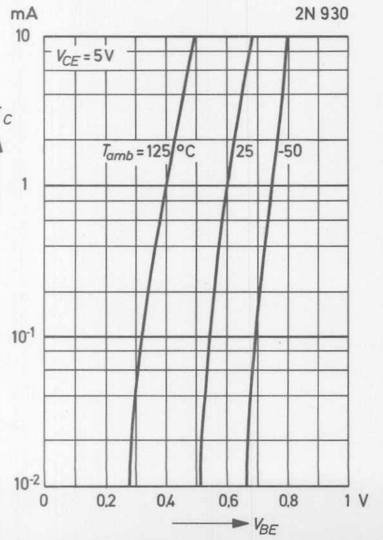
**Common emitter collector characteristics**



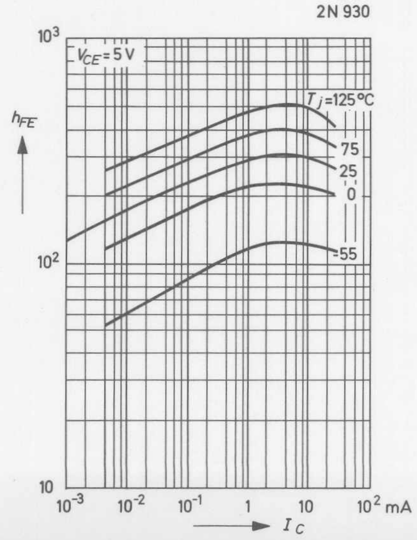

**Common emitter collector characteristics**



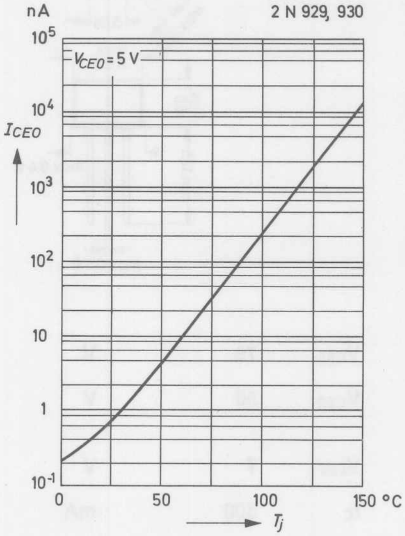

**Collector current versus base emitter voltage**



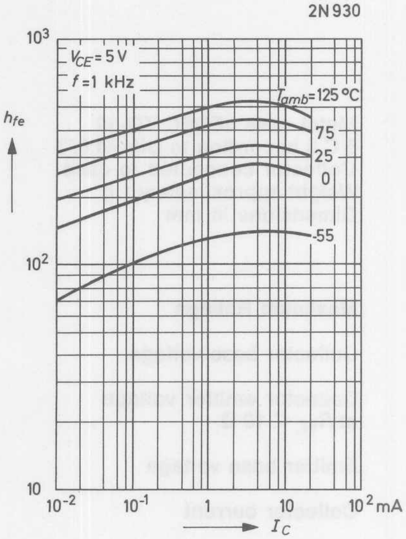

**DC current gain versus collector current**



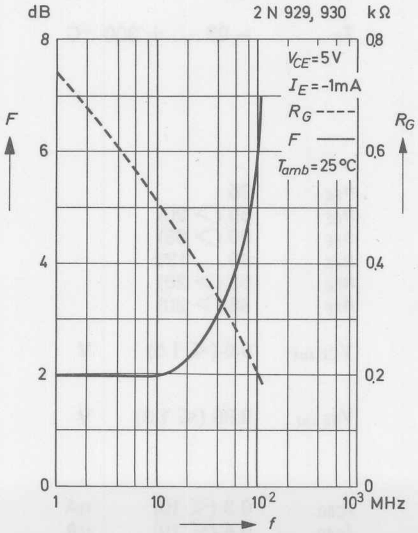
**Collector cutoff current versus junction temperature**



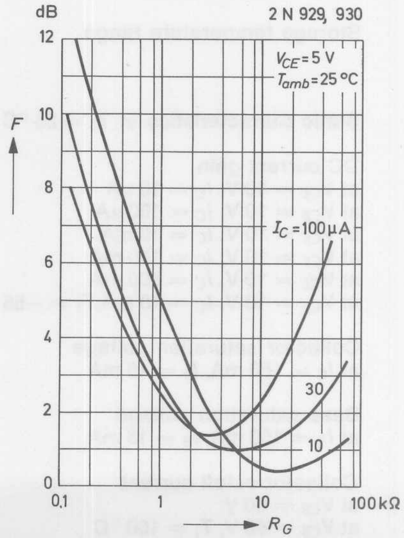

**Small signal current gain versus collector current**




**Noise figure versus frequency**

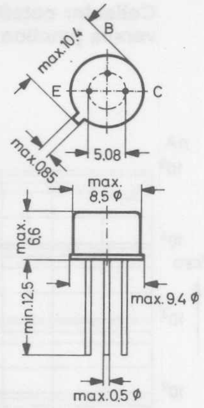



**Noise figure versus generator resistance**



# 2 N 1613

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 75 | V |
| Collector emitter voltage at $R_{BE} < 10\ \Omega$ | $V_{CER}$ | 50 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | − 65 ... + 300 | °C |

**Static characteristics** at $T_j = 25\ °C$

| | | | |
|---|---|---|---|
| DC current gain at $V_{CE} = 10$ V, $I_C = 10\ \mu A$ | $h_{FE}$ | 35 | |
| at $V_{CE} = 10$ V, $I_C = 100\ \mu A$ | $h_{FE}$ | 50 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 80 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 ... 120 | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 55 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA, $T_j = -55\ °C$ | $h_{FE}$ | 35 (> 20) | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 0.6 (< 1.5) | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 0.95 (< 1.3) | V |
| Collector cutoff current at $V_{CB} = 60$ V | $I_{CBO}$ | 0.3 (< 10) | nA |
| at $V_{CB} = 60$ V, $T_j = 150\ °C$ | $I_{CBO}$ | 0.4 (< 10) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current<br>at $V_{EB} = 5$ V | $I_{EB0}$ | 0.05 (< 10) | nA |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | $R_{thA}$<br>$R_{thC}$ | < 220<br>< 58 | °C/W<br>°C/W |

**Dynamic characteristics** at $T_{amb} = 25$ °C

| | | | |
|---|---|---|---|
| Collector base capacitance<br>at $V_{CB} = 10$ V | $C_{CB0}$ | 18 (< 25) | pF |
| Gain bandwidth product<br>at $V_{CE} = 10$ V, $I_C = 50$ mA | $f_T$ | 80 (> 60) | MHz |

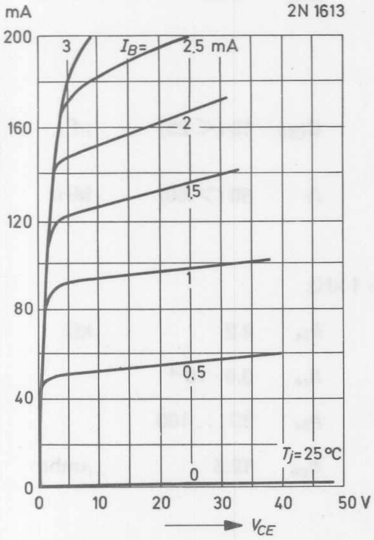
*h*-parameters, grounded emitter
Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, $f = 1$ kHz

| | | | |
|---|---|---|---|
| Input impedance | $h_{ie}$ | 2.2 | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | $3.6 \cdot 10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 30 . . . 100 | |
| Output admittance | $h_{oe}$ | 12.5 | µmho |

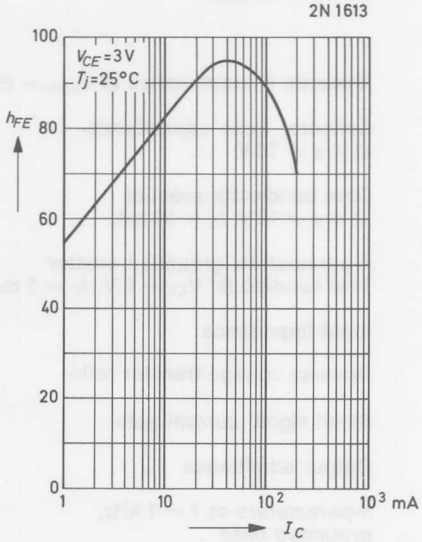
*h*-parameters at $f = 1$ kHz,
grounded base

| | | | |
|---|---|---|---|
| Input impedance<br>at $V_{CB} = 5$ V, $-I_E = 1$ mA<br>at $V_{CB} = 10$ V, $-I_E = 5$ mA | <br>$h_{ib}$<br>$h_{ib}$ | <br>24 . . . 34<br>4 . . . 8 | <br>Ω<br>Ω |
| Reverse voltage transfer ratio<br>at $V_{CB} = 5$ V, $-I_E = 1$ mA<br>at $V_{CB} = 10$ V, $-I_E = 5$ mA | <br>$h_{rb}$<br>$h_{rb}$ | <br>$0.7 (< 3) \cdot 10^{-4}$<br>$0.8 (< 3) \cdot 10^{-4}$ | |
| Output admittance<br>at $V_{CB} = 5$ V, $-I_E = 1$ mA<br>at $V_{CB} = 10$ V, $-I_E = 5$ mA | <br>$h_{ob}$<br>$h_{ob}$ | <br>0.1 . . . 0.5<br>0.1 . . . 1 | <br>µmho<br>µmho |
| Noise figure<br>at $V_{CE} = 10$ V, $I_C = 0.3$ mA,<br>$R_G = 500$ Ω, $f = 1$ kHz | $F$ | 6 (< 12) | dB |

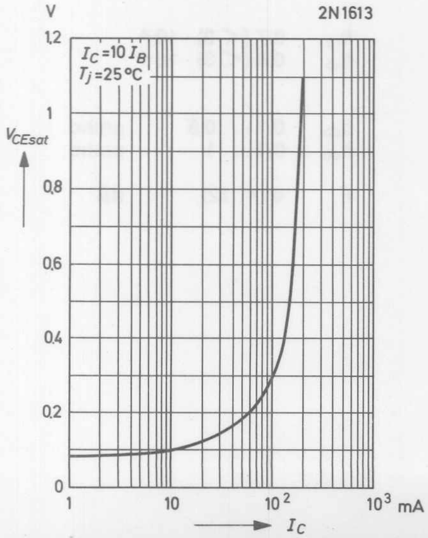
**Common emitter collector characteristics**



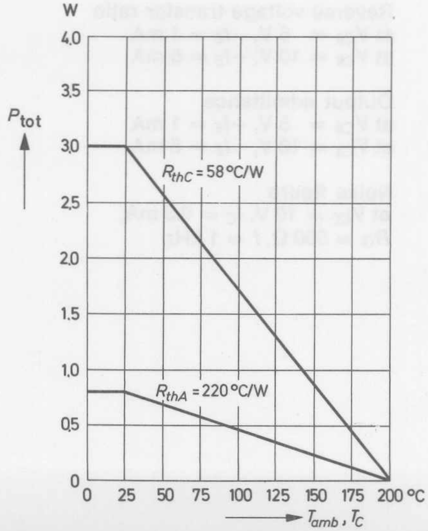

**DC current gain versus collector current**




**Collector saturation voltage versus collector current**

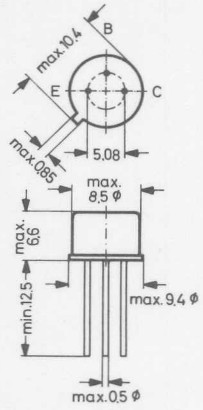



**Admissible power dissipation versus temperature**



# 2 N 1711

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 75 | V |
| Collector emitter voltage at $R_{BE} < 10\ \Omega$ | $V_{CER}$ | 50 | V |
| Emitter base voltage | $V_{EBO}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +300$ | °C |

**Static characteristics** at $T_j = 25\ °C$

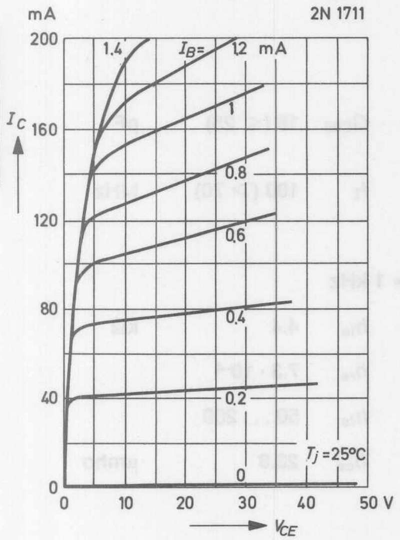
| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 10\ \mu A$ | $h_{FE}$ | 60 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 100\ \mu A$ | $h_{FE}$ | 80 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 130 (> 75) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 100 . . . 300 | |
| at $V_{CE} = 10$ V, $I_C = 500$ mA | $h_{FE}$ | 75 (> 40) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA, $T_j = -55\ °C$ | $h_{FE}$ | 65 (> 35) | |
| Collector saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 0.5 (< 1.5) | V |
| Base saturation voltage at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 0.95 (< 1.3) | V |
| Collector cutoff current | | | |
| at $V_{CB} = 60$ V | $I_{CBO}$ | 0.3 (< 10) | nA |
| at $V_{CB} = 60$ V, $T_j = 150\ °C$ | $I_{CBO}$ | 0.4 (< 10) | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EBO}$ | 0.05 (< 5) | nA |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 58 | °C/W |

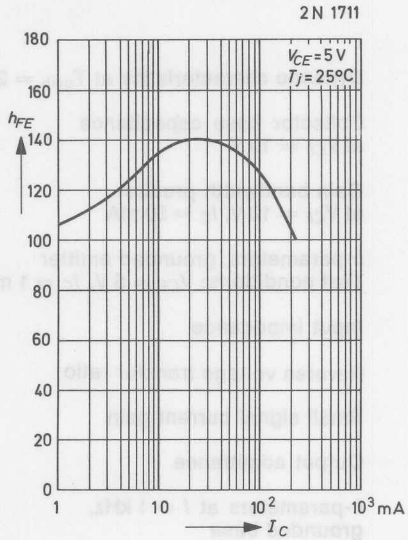
**Dynamic characteristics** at $T_{amb} = 25$ °C

| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CB} = 10$ V | $C_{CBO}$ | 18 (< 25) | pF |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA | $f_T$ | 100 (> 70) | MHz |
| *h*-parameters, grounded emitter Test conditions: $V_{CE} = 5$ V, $I_C = 1$ mA, $f = 1$ kHz | | | |
| Input impedance | $h_{ie}$ | 4.4 | kΩ |
| Reverse voltage transfer ratio | $h_{re}$ | $7.3 \cdot 10^{-4}$ | |
| Small signal current gain | $h_{fe}$ | 50 . . . 200 | |
| Output admittance | $h_{oe}$ | 23.8 | μmho |
| *h*-parameters at $f = 1$ kHz, grounded base | | | |
| Input impedance | | | |
| at $V_{CB} = 5$ V, $-I_E = 1$ mA | $h_{ib}$ | 24 . . . 34 | Ω |
| at $V_{CB} = 10$ V, $-I_E = 5$ mA | $h_{ib}$ | 4 . . . 8 | Ω |
| Reverse voltage transfer ratio | | | |
| at $V_{CB} = 5$ V, $-I_E = 1$ mA | $h_{rb}$ | $1.2 (< 5) \cdot 10^{-4}$ | |
| at $V_{CB} = 10$ V, $-I_E = 5$ mA | $h_{rb}$ | $1.2 (< 5) \cdot 10^{-4}$ | |
| Output admittance | | | |
| at $V_{CB} = 5$ V, $-I_E = 1$ mA | $h_{ob}$ | 0.1 . . . 0.5 | μmho |
| at $V_{CB} = 10$ V, $-I_E = 5$ mA | $h_{ob}$ | 0.1 . . . 1 | μmho |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.3$ mA, $R_G = 500\ \Omega$, $f = 1$ kHz | $F$ | 3.5 (< 8) | dB |

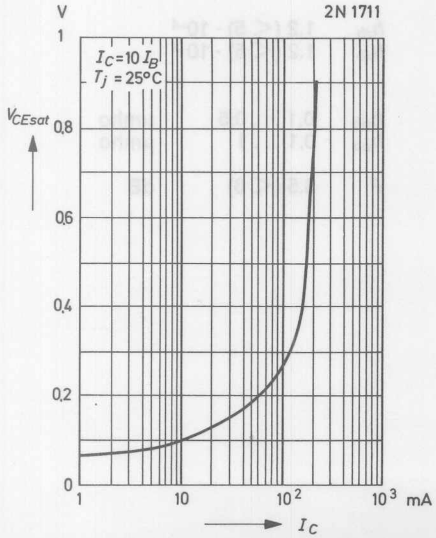
**Common emitter collector characteristics**



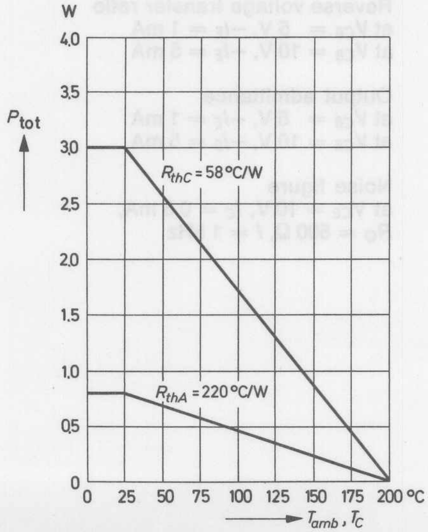

**DC current gain versus collector current**




**Collector saturation voltage versus collector current**

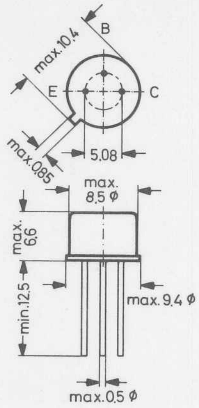



**Admissible power dissipation versus temperature**



# 2 N 1893

**NPN Silicon Epitaxial Planar Transistor**
for switching and amplifier applications




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 120 | V |
| Collector emitter voltage | | | |
| at $I_B = 0$ | $V_{CE0}$ | 80 | V |
| at $R_{BE} < 10\ \Omega$ | $V_{CER}$ | 100 | V |
| Emitter base voltage | $V_{EB0}$ | 7 | V |
| Collector current | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +300$ | °C |

**Static Characteristics** at $T_j = 25\ °C$

| | | | |
|---|---|---|---|
| DC current gain | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | 50 (> 20) | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | 80 (> 35) | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 . . . 120 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA, $T_j = -55\ °C$ | $h_{FE}$ | 40 (> 20) | |
| Collector saturation voltage | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | 2 (< 5) | V |
| at $I_C = 50$ mA, $I_B = 5$ mA | $V_{CE\,sat}$ | 0.5 (< 1.2) | V |
| Base saturation voltage | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | 0.96 (< 1.3) | V |
| at $I_C = 50$ mA, $I_B = 5$ mA | $V_{BE\,sat}$ | 0.82 (< 0.9) | V |

| | | | |
|---|---|---|---|
| Collector cutoff current | | | |
| at $V_{CB} = 90$ V | $I_{CB0}$ | 0.3 (< 10) | nA |
| at $V_{CB} = 90$ V, $T_j = 150$ °C | $I_{CB0}$ | 1.5 (< 15) | μA |
| Emitter cutoff current at $V_{EB} = 5$ V | $I_{EB0}$ | < 10 | nA |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 58 | °C/W |

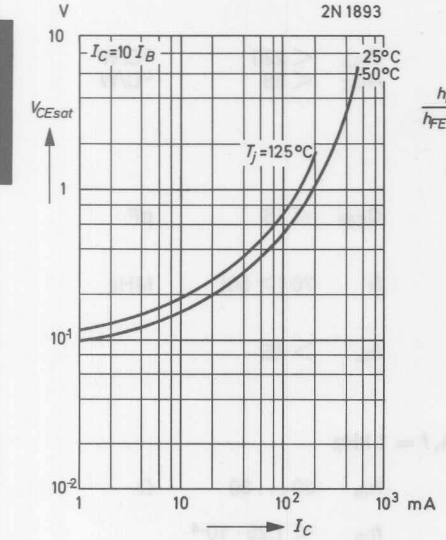
**Dynamic characteristics** at $T_C = 25$ °C

| | | | |
|---|---|---|---|
| Collector base capacitance at $V_{CB} = 10$ V | $C_{CB0}$ | < 15 | pF |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 50$ mA | $f_T$ | 70 (> 50) | MHz |
| Small signal current gain at $V_{CE} = 10$ V, $I_C = 5$ mA, $f = 1$ kHz | $h_{fe}$ | > 45 | |

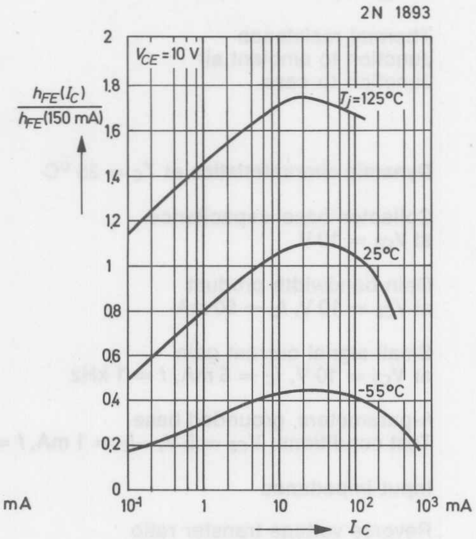
*h*-parameters, grounded base
Test conditions: $V_{CE} = 5$ V, $-I_E = 1$ mA, $f = 1$ kHz

| | | | |
|---|---|---|---|
| Input impedance | $h_{ib}$ | 20 . . . 30 | Ω |
| Reverse voltage transfer ratio | $h_{rb}$ | $< 1.25 \cdot 10^{-4}$ | |
| Output admittance | $h_{ob}$ | < 0.5 | μmho |

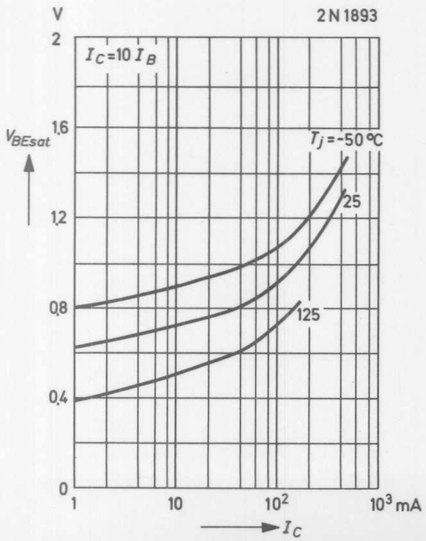
**Collector saturation voltage versus collector current**



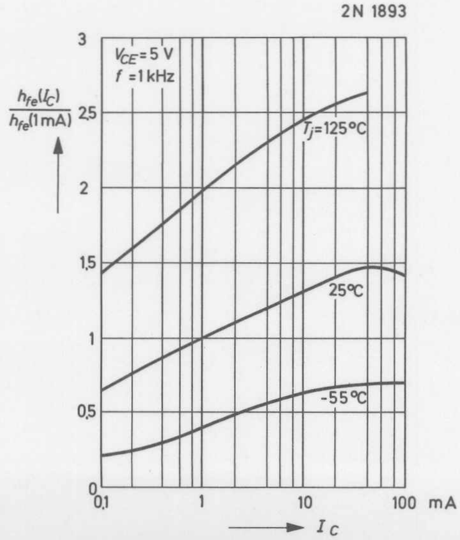

**Relative DC current gain versus collector current**



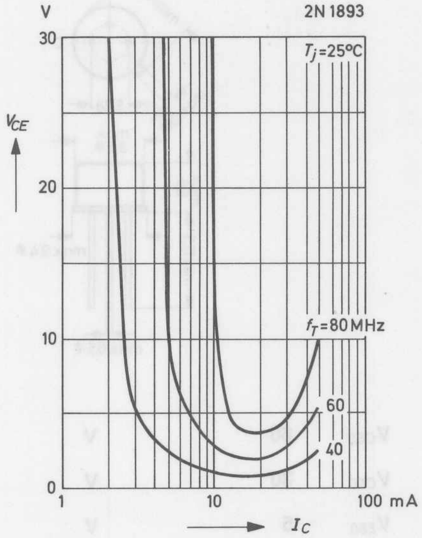

**Base saturation voltage versus collector current**



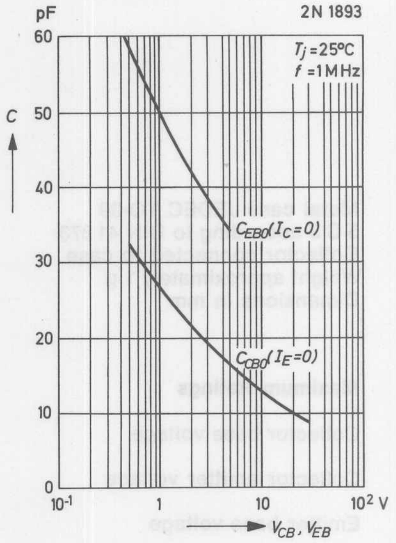

**Relative small signal current gain versus collector current**



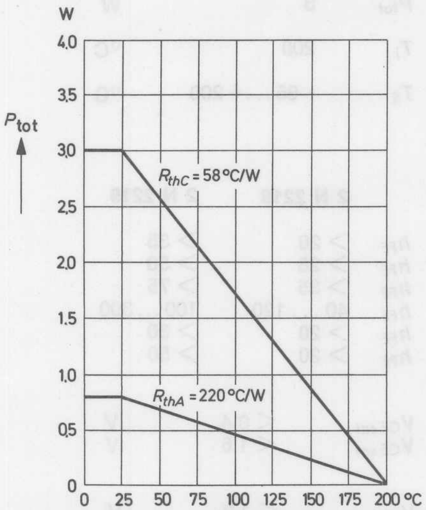
**Contours of constant gain bandwidth product**




**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**

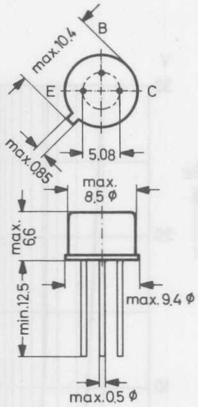



**Admissible power dissipation versus temperature**



# 2 N 2218, 2 N 2219

**NPN Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 60 | V |
| Collector emitter voltage | $V_{CEO}$ | 30 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 0.8 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +200$ | °C |

**Characteristics** at $T_j = 25\ °C$

| | | 2 N 2218 | 2 N 2219 | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | $> 20$ | $> 35$ | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | $> 25$ | $> 50$ | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | $> 35$ | $> 75$ | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | $40 \ldots 120$ | $100 \ldots 300$ | |
| at $V_{CE} = 10$ V, $I_C = 0.5$ A | $h_{FE}$ | $> 20$ | $> 30$ | |
| at $V_{CE} = 1$ V, $I_C = 150$ mA | $h_{FE}$ | $> 20$ | $> 50$ | |
| Collector saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | $< 0.4$ | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | $< 1.6$ | | V |
| Base saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | $< 1.3$ | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{BE\,sat}$ | $< 2.6$ | | V |

| | | | |
|---|---|---|---|
| Collector cutoff current | | | |
| at $V_{CB} = 50$ V | $I_{CB0}$ | $< 10$ | nA |
| at $V_{CB} = 50$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | $< 10$ | µA |
| Collector base breakdown voltage at $I_C = 10$ µA | $V_{(BR)CB0}$ | $> 60$ | V |
| Collector emitter breakdown voltage at $I_C = 10$ mA | $V_{(BR)CE0}$ | $> 30$ | V |
| Emitter base breakdown voltage at $I_E = 10$ µA | $V_{(BR)EB0}$ | $> 5$ | V |
| Gain bandwidth product at $V_{CE} = 20$ V, $I_C = 20$ mA, $f = 100$ MHz | $f_T$ | $> 250$ | MHz |
| Collector base capacitance at $V_{CB0} = 10$ V, $f = 100$ kHz | $C_{CB0}$ | $< 8$ | pF |
| Emitter base capacitance at $V_{EB0} = 0.5$ V, $f = 100$ kHz | $C_{EB0}$ | $< 30$ | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 220$ | °C/W |
| Junction to case | $R_{thC}$ | $< 58$ | °C/W |
| Turn-on time (see Fig. 1) | $t_{on}$ | 26 | ns |
| Turn-off time (see Fig. 2) | $t_{off}$ | 70 | ns |
| Total switching time (see Fig. 3) | $t_{total}$ | 12 | ns |

Curves and characteristics of types BSW 82 . . . 85 are valid analogously for types 2 N 2218 and 2 N 2219.

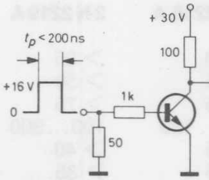



Fig. 1: Test circuit for turn-on time, saturated operation

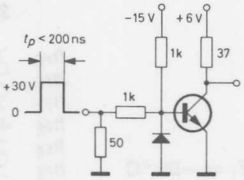



Fig. 2: Test circuit for turn-off time, saturated operation

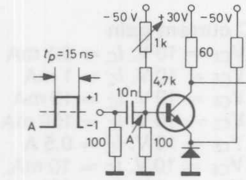
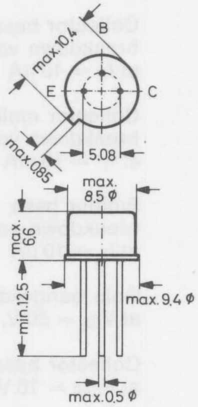



Fig. 3: Test circuit for non-saturated operation

# 2 N 2218 A, 2 N 2219 A

**NPN Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-39
5 C 3 according to DIN 41873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 75 | V |
| Collector emitter voltage | $V_{CE0}$ | 40 | V |
| Emitter base voltage | $V_{EB0}$ | 6 | V |
| Collector current | $I_C$ | 0.8 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\,°C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\,°C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | –65…+200 | °C |

**Characteristics** at $T_j = 25\,°C$

| | | 2 N 2218 A | 2 N 2219 A | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | > 20 | > 35 | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | > 25 | > 50 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | > 35 | > 75 | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 … 120 | 100…300 | |
| at $V_{CE} = 10$ V, $I_C = 0.5$ A | $h_{FE}$ | > 25 | > 40 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA, $T_j = -55\,°C$ | $h_{FE}$ | > 15 | > 35 | |
| at $V_{CE} = 1$ V, $I_C = 150$ mA | $h_{FE}$ | > 20 | > 50 | |
| Collector saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | < 0.3 | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | < 1 | | V |
| Base saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | < 1.2 | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{BE\,sat}$ | < 2 | | V |

| | | | |
|---|---|---|---|
| Collector cutoff current | | | |
| at $V_{CB} = 60$ V | $I_{CB0}$ | $< 10$ | nA |
| at $V_{CB} = 60$ V, $T_{amb} = 150$ °C | $I_{CB0}$ | $< 10$ | µA |
| at $V_{CE} = 60$ V, $V_{EB} = 3$ V | $I_{CEV}$ | $< 10$ | nA |
| Emitter cutoff current at $V_{EB} = 3$ V | $I_{EB0}$ | $< 10$ | nA |
| Base cutoff current at $V_{CE} = 60$ V, $V_{EB} = 3$ V | $I_{EBV}$ | $< 20$ | nA |
| Collector base breakdown voltage at $I_C = 10$ µA | $V_{(BR)CB0}$ | $> 75$ | V |
| Collector emitter breakdown voltage at $I_C = 10$ mA | $V_{(BR)CE0}$ | $> 40$ | V |
| Emitter base breakdown voltage at $I_E = 10$ µA | $V_{(BR)EB0}$ | $> 6$ | V |

$h$-parameters at $f = 1$ kHz

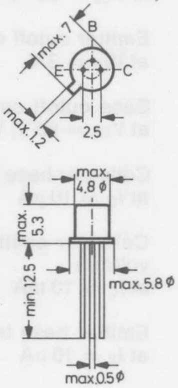
| | | **2 N 2218 A** | **2 N 2219 A** | |
|---|---|---|---|---|
| Input impedance | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{ie}$ | 1 ... 3.5 | 2 ... 8 | kΩ |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{ie}$ | 0.2 ... 1 | 0.25 ... 1.25 | kΩ |
| Reverse voltage transfer ratio | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{re}$ | $< 5 \cdot 10^{-4}$ | $< 8 \cdot 10^{-4}$ | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{re}$ | $< 2.5 \cdot 10^{-4}$ | $< 4 \cdot 10^{-4}$ | |
| Small signal current gain | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{fe}$ | 30 ... 150 | 50 ... 300 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{fe}$ | 50 ... 300 | 75 ... 375 | |
| Output admittance | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{oe}$ | 3 ... 15 | 5 ... 35 | µmho |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{oe}$ | 10 ... 100 | 25 ... 200 | µmho |
| Collector base time constant at $V_{CE} = 20$ V, $I_C = 20$ mA, $f = 31.8$ MHz | $r_{b'}C_c$ | $< 150$ | $< 150$ | ps |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.1$ mA, $R_G = 1$ kΩ, $f = 1$ kHz | $F$ | – | $< 4$ | dB |

| | | | |
|---|---|---|---|
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 220$ | °C/W |
| Junction to case | $R_{thC}$ | $< 58$ | °C/W |

Curves and characteristics of types BSW 82 ... 85 are valid analogously for types 2 N 2218 A and 2 N 2219 A.

# 2 N 2221, 2 N 2222

**NPN Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 60 | V |
| Collector emitter voltage | $V_{CEO}$ | 30 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 0.8 | A |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.5 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1.8 | W |
| Junction temperature | $T_j$ | 175 | °C |
| Storage temperature range | $T_S$ | −65 ... +200 | °C |

**Characteristics** at $T_j = 25\ °C$

| | | 2 N 2221 | 2 N 2222 | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | > 20 | > 35 | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | > 25 | > 50 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | > 35 | > 75 | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 ... 120 | 100 ... 300 | |
| at $V_{CE} = 10$ V, $I_C = 0.5$ A | $h_{FE}$ | > 20 | > 30 | |
| Collector saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | < 0.4 | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | < 1.6 | | V |
| Base saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | < 1.3 | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{BE\,sat}$ | < 2.6 | | V |

| | | | |
|---|---|---|---|
| Collector cutoff current<br>at $V_{CB} = 50$ V<br>at $V_{CB} = 50$ V, $T_{amb} = 150$ °C | <br>$I_{CBO}$<br>$I_{CBO}$ | <br>$< 10$<br>$< 10$ | <br>nA<br>µA |
| Collector base breakdown voltage<br>at $I_C = 10$ µA | $V_{(BR)CBO}$ | $> 60$ | V |
| Collector emitter breakdown voltage<br>at $I_C = 10$ mA | $V_{(BR)CEO}$ | $> 30$ | V |
| Emitter base breakdown voltage<br>at $I_E = 10$ µA | $V_{(BR)EBO}$ | $> 5$ | V |
| Gain bandwidth product<br>at $V_{CE} = 20$ V, $I_C = 20$ mA, $f = 100$ MHz | $f_T$ | $> 250$ | MHz |
| Collector base capacitance<br>at $V_{CBO} = 10$ V, $f = 100$ kHz | $C_{CBO}$ | $< 8$ | pF |
| Emitter base capacitance<br>at $V_{EBO} = 0.5$ V, $f = 100$ kHz | $C_{EBO}$ | $< 30$ | pF |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{thA}$<br>$R_{thC}$ | <br>$< 300$<br>$< 84$ | <br>°C/W<br>°C/W |
| Turn-on time<br>(see Fig. 1) | $t_{on}$ | 26 | ns |
| Turn-off time<br>(see Fig. 2) | $t_{off}$ | 70 | ns |
| Total switching time<br>(see Fig. 3) | $t_{total}$ | 12 | ns |

Curves and characteristics of types BSW 82 . . . 85 are valid analogously for types 2 N 2221 and 2 N 2222.

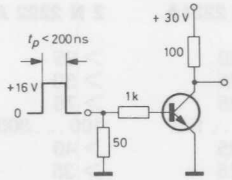



Fig. 1: Test circuit for turn-on time, saturated operation

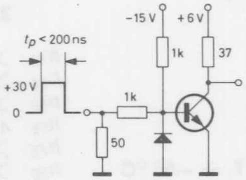



Fig. 2: Test circuit for turn-off time, saturated operation

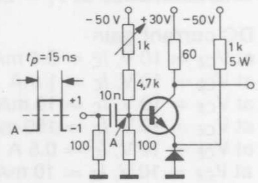
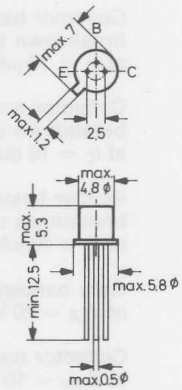



Fig. 3: Test circuit for non-saturated operation

# 2 N 2221 A, 2 N 2222 A

**NPN Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-18
18 A 3 according to DIN 41876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 75 | V |
| Collector emitter voltage | $V_{CE0}$ | 40 | V |
| Emitter base voltage | $V_{EB0}$ | 6 | V |
| Collector current | $I_C$ | 0.8 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.5 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1.8 | W |
| Junction temperature | $T_j$ | 175 | °C |
| Storage temperature range | $T_S$ | −65 ... +200 | °C |

**Characteristics** at $T_j = 25\ °C$

| | | 2 N 2221 A | 2 N 2222 A | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $V_{CE} = 10$ V, $I_C = 0.1$ mA | $h_{FE}$ | > 20 | > 35 | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{FE}$ | > 25 | > 50 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{FE}$ | > 35 | > 75 | |
| at $V_{CE} = 10$ V, $I_C = 150$ mA | $h_{FE}$ | 40 ... 120 | 100 ... 300 | |
| at $V_{CE} = 10$ V, $I_C = 0.5$ A | $h_{FE}$ | > 25 | > 40 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA, $T_j = -55\ °C$ | $h_{FE}$ | > 15 | > 35 | |
| at $V_{CE} = 1$ V, $I_C = 150$ mA | $h_{FE}$ | > 20 | > 50 | |
| Collector saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{CE\,sat}$ | < 0.3 | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{CE\,sat}$ | < 1 | | V |
| Base saturation voltage | | | | |
| at $I_C = 150$ mA, $I_B = 15$ mA | $V_{BE\,sat}$ | < 1.2 | | V |
| at $I_C = 500$ mA, $I_B = 50$ mA | $V_{BE\,sat}$ | < 2 | | V |

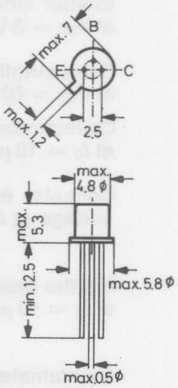
| | | | | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $V_{CB} = 60$ V | $I_{CBO}$ | $< 10$ | | nA |
| at $V_{CB} = 60$ V, $T_{amb} = 150$ °C | $I_{CBO}$ | $< 10$ | | µA |
| at $V_{CE} = 60$ V, $V_{EB} = 3$ V | $I_{CEV}$ | $< 10$ | | nA |
| Emitter cutoff current at $V_{EB} = 3$ V | $I_{EBO}$ | $< 10$ | | nA |
| Base cutoff current at $V_{CE} = 60$ V, $V_{EB} = 3$ V | $I_{EBV}$ | $< 20$ | | nA |
| Collector base breakdown voltage at $I_C = 10$ µA | $V_{(BR)CBO}$ | $> 75$ | | V |
| Collector emitter breakdown voltage at $I_C = 10$ mA | $V_{(BR)CEO}$ | $> 40$ | | V |
| Emitter base breakdown voltage at $I_E = 10$ µA | $V_{(BR)EBO}$ | $> 6$ | | V |

$h$-parameters at $f = 1$ kHz

| | | 2 N 2221 A | 2 N 2222 A | |
|---|---|---|---|---|
| Input impedance | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{ie}$ | 1 . . . 3.5 | 2 . . . 8 | kΩ |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{ie}$ | 0.2 . . . 1 | 0.25 . . . 1.25 | kΩ |
| Reverse voltage transfer ratio | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{re}$ | $< 5 \cdot 10^{-4}$ | $< 8 \cdot 10^{-4}$ | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{re}$ | $< 2.5 \cdot 10^{-4}$ | $< 4 \cdot 10^{-4}$ | |
| Small signal current gain | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{fe}$ | 30 . . . 150 | 50 . . . 300 | |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{fe}$ | 50 . . . 300 | 75 . . . 375 | |
| Output admittance | | | | |
| at $V_{CE} = 10$ V, $I_C = 1$ mA | $h_{oe}$ | 3 . . . 15 | 5 . . . 35 | µmho |
| at $V_{CE} = 10$ V, $I_C = 10$ mA | $h_{oe}$ | 10 . . . 100 | 25 . . . 200 | µmho |
| Collector base time constant at $V_{CE} = 20$ V, $I_C = 20$ mA, $f = 31.8$ MHz | $r_{b'} C_c$ | $< 150$ | $< 150$ | ps |
| Noise figure at $V_{CE} = 10$ V, $I_C = 0.1$ mA, $R_G = 1$ kΩ, $f = 1$ kHz | $F$ | – | $< 4$ | dB |
| Thermal resistance | | | | |
| Junction to ambient air | $R_{thA}$ | | $< 300$ | °C/W |
| Junction to case | $R_{thC}$ | | $< 84$ | °C/W |

Curves and characteristics of types BSW 82 . . . 85 are valid analogously for types 2 N 2221 A and 2 N 2222 A.

**NPN Silicon Epitaxial Planar Transistor**
for switching applications at switching frequencies up to 50 ... 100 MHz and collector currents from 0.1 to 100 mA.




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

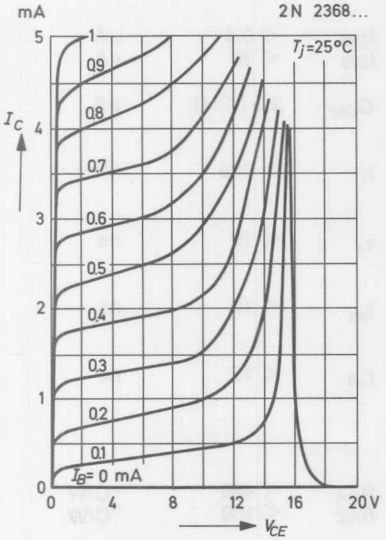
| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 40 | V |
| Collector emitter voltage | | | |
| at $V_{BE} = 0$ | $V_{CES}$ | 40 | V |
| at $I_B = 0$ | $V_{CE0}$ | 15 | V |
| Emitter base voltage | $V_{EB0}$ | 4.5 | V |
| Collector current | $I_C$ | 200 | mA |
| Collector current, pulsed $t_p = 10\ \mu s$ duration | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.36 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1.2 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | − 65 ... + 200 | °C |

**Characteristics** at $T_j = 25\ °C$

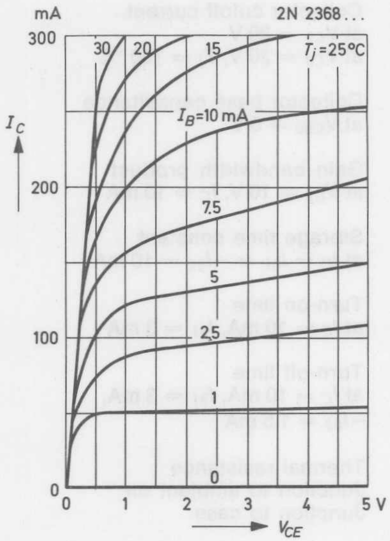
| | | |
|---|---|---|
| DC current gain | | |
| at $V_{CE} = 1$ V, $I_C = 10$ mA | $h_{FE}$ | 20 ... 60 |
| at $V_{CE} = 1$ V, $I_C = 10$ mA, $T_j = -55\ °C$ | $h_{FE}$ | $>10$ |
| at $V_{CE} = 2$ V, $I_C = 100$ mA | $h_{FE}$ | $>10$ |

| | | | |
|---|---|---|---|
| Collector saturation voltage at $I_C = 10$ mA, $I_B = 1$ mA | $V_{CE\,sat}$ | 0.2 ($<$ 0.25) | V |
| Base saturation voltage at $I_C = 10$ mA, $I_B = 1$ mA | $V_{BE\,sat}$ | 0.7 . . . 0.85 | V |
| Collector cutoff current at $V_{CB} = 20$ V | $I_{CB0}$ | $<$ 0.4 | μA |
| at $V_{CB} = 20$ V, $T_j = 150\,°C$ | $I_{CB0}$ | $<$ 30 | μA |
| Collector base capacitance at $V_{CB0} = 5$ V | $C_{CB0}$ | 2.5 ($<$ 4) | pF |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 10$ mA | $f_T$ | $>$ 400 | MHz |
| Storage time constant at $I_C = I_{B1} = -I_{B2} = 10$ mA | $\tau_s$ | $<$ 10 | ns |
| Turn-on time at $I_C = 10$ mA, $I_{B1} = 3$ mA | $t_{on}$ | $<$ 12 | ns |
| Turn-off time at $I_C = 10$ mA, $I_{B1} = 3$ mA, $-I_{B2} = 1.5$ mA | $t_{off}$ | $<$ 15 | ns |
| Thermal resistance Junction to ambient air | $R_{thA}$ | $<$ 480 | °C/W |
| Junction to case | $R_{thC}$ | $<$ 150 | °C/W |

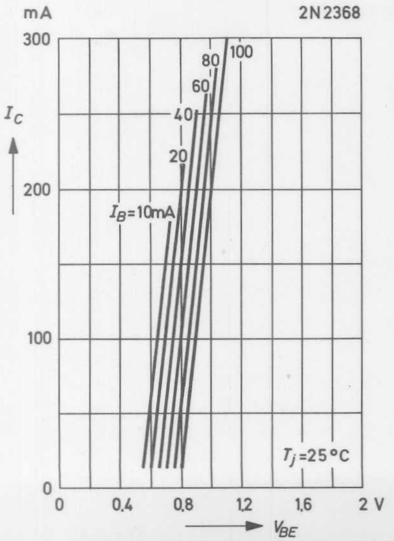
**Common emitter collector characteristics**



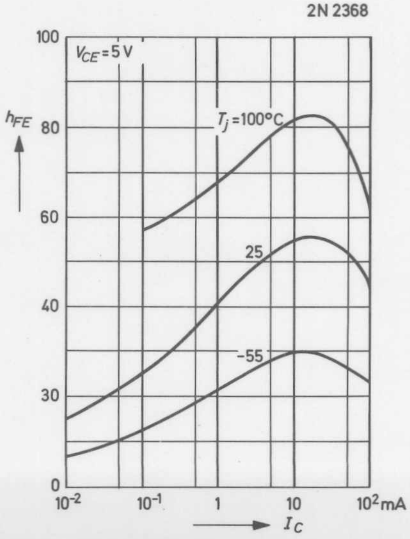

**Common emitter collector characteristics**



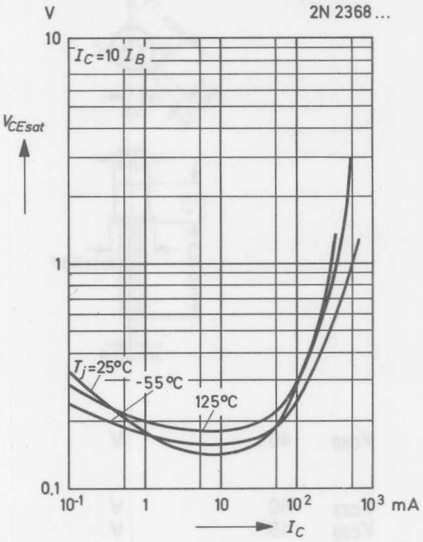

**Collector current versus base emitter voltage**



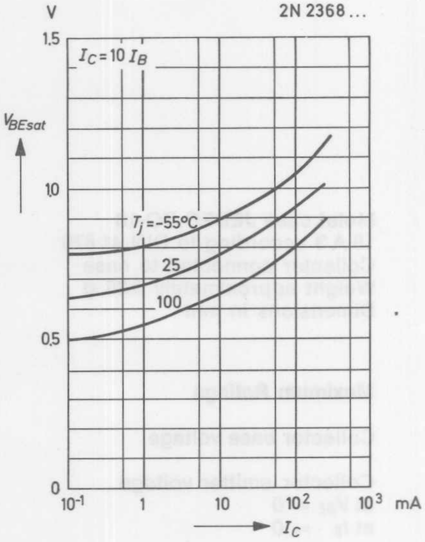

**DC current gain versus collector current**



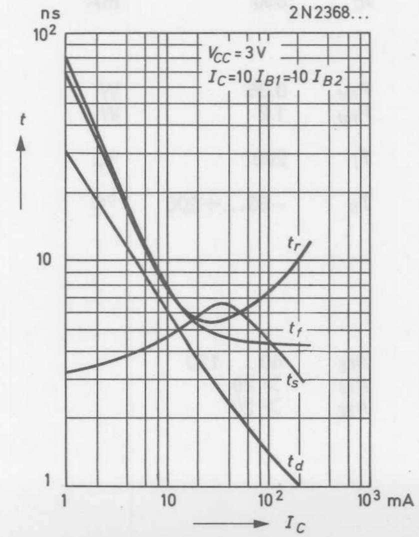
**Collector saturation voltage versus collector current**



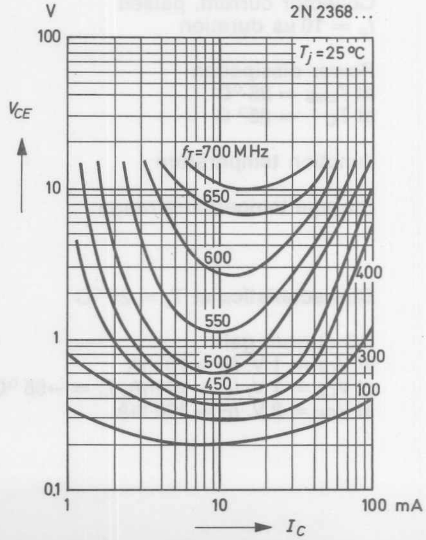

**Base saturation voltage versus collector current**



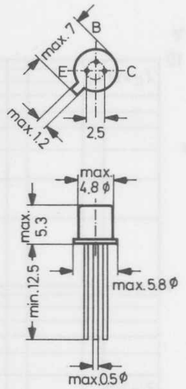

**Switching times versus collector current**




**Contours of constant gain bandwidth product**



**NPN Silicon Epitaxial Planar Transistor**
for switching applications at switching frequencies up to 50 . . . 100 MHz and collector currents from 0.1 to 100 mA.




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | V |
| Collector emitter voltage | | | |
| at $V_{BE} = 0$ | $V_{CES}$ | 40 | V |
| at $I_B = 0$ | $V_{CEO}$ | 15 | V |
| Emitter base voltage | $V_{EBO}$ | 4.5 | V |
| Collector current | $I_C$ | 200 | mA |
| Collector current, pulsed $t_p = 10\ \mu s$ duration | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.36 | W |
| at $T_C = 25°\ C$ | $P_{tot}$ | 1.2 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | −65...+200 | °C |

**Characteristics** at $T_j = 25\ °C$

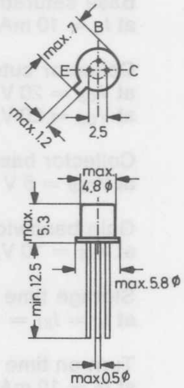
| | | |
|---|---|---|
| DC current gain | | |
| at $V_{CE} = 1\ V$, $I_C = 10\ mA$ | $h_{FE}$ | 40 . . . 120 |
| at $V_{CE} = 1\ V$, $I_C = 10\ mA$, $T_j = -55\ °C$ | $h_{FE}$ | $> 20$ |
| at $V_{CE} = 2\ V$, $I_C = 100\ mA$ | $h_{FE}$ | $> 20$ |

| | | | |
|---|---|---|---|
| Collector saturation voltage at $I_C = 10$ mA, $I_B = 1$ mA | $V_{CE\,sat}$ | 0.2 (< 0.25) | V |
| Base saturation voltage at $I_C = 10$ mA, $I_B = 1$ mA | $V_{BE\,sat}$ | 0.7 . . . 0.85 | V |
| Collector cutoff current | | | |
| at $V_{CB} = 20$ V | $I_{CB0}$ | < 0.4 | µA |
| at $V_{CB} = 20$ V, $T_j = 150$ °C | $I_{CB0}$ | < 30 | µA |
| Collector base capacitance at $V_{CB0} = 5$ V | $C_{CB0}$ | 2.5 (< 4) | pF |
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 10$ mA | $f_T$ | > 500 | MHz |
| Storage time constant at $I_C = I_{B1} = -I_{B2} = 10$ mA | $\tau_s$ | < 13 | ns |
| Turn-on time at $I_C = 10$ mA, $I_{B1} = 3$ mA | $t_{on}$ | < 12 | ns |
| Turn-off time at $I_C = 10$ mA, $I_{B1} = 3$ mA, $-I_{B2} = 1.5$ mA | $t_{off}$ | < 18 | ns |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 480 | °C/W |
| Junction to case | $R_{thC}$ | < 150 | °C/W |

**Curves and characteristics of type 2 N 2368 are valid analogously for type 2 N 2369.**

# 2 N 2369 A

**NPN Silicon Epitaxial Planar Transistor**
for switching applications at switching frequencies up to 50 . . . 100 MHz and collector currents from 0.1 to 100 mA.




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CB0}$ | 40 | V |
| Collector emitter voltage | | | |
| at $V_{BE} = 0$ | $V_{CES}$ | 40 | V |
| at $I_B = 0$ | $V_{CE0}$ | 15 | V |
| Emitter base voltage | $V_{EB0}$ | 4.5 | V |
| Collector current | $I_C$ | 200 | mA |
| Collector current, pulsed $t_p = 10\ \mu s$ duration | $I_C$ | 500 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.36 | W |
| at $T_C = 25°\ C$ | $P_{tot}$ | 1.2 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | − 65 . . . + 200 | °C |

**Characteristics** at $T_j = 25\ °C$

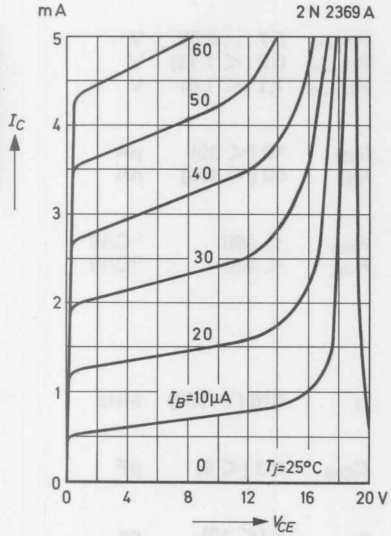
| | | |
|---|---|---|
| DC current gain | | |
| at $V_{CE} = 1$ V, $I_C = 10$ mA | $h_{FE}$ | 40 . . . 120 (66) |
| at $V_{CE} = 0.35$ V, $I_C = 10$ mA | $h_{FE}$ | 40 . . . 120 (63) |
| at $V_{CE} = 0.4$ V, $I_C = 30$ mA | $h_{FE}$ | 70 (> 30) |
| at $V_{CE} = 1$ V, $I_C = 100$ mA | $h_{FE}$ | > 20 |
| at $V_{CE} = 0.35$ V, $I_C = 10$ mA, $T_j = -55\ °C$ | $h_{FE}$ | 50 (> 20) |

| | | | |
|---|---|---|---|
| Collector saturation voltage | | | |
| at $I_C = 10$ mA, $I_B = 1$ mA | $V_{CE\,sat}$ | 0.14 (< 0.2) | V |
| at $I_C = 30$ mA, $I_B = 3$ mA | $V_{CE\,sat}$ | 0.17 (< 0.25) | V |
| at $I_C = 100$ mA, $I_B = 10$ mA | $V_{CE\,sat}$ | 0.28 (< 0.5) | V |
| at $I_C = 10$ mA, $I_B = 1$ mA, $T_j = 125\,°C$ | $V_{CE\,sat}$ | 0.19 (< 0.3) | V |
| Base saturation voltage | | | |
| at $I_C = 10$ mA, $I_B = 1$ mA | $V_{BE\,sat}$ | 0.7 . . . 0.85 | V |
| at $I_C = 30$ mA, $I_B = 3$ mA | $V_{BE\,sat}$ | 0.9 (< 1.15) | V |
| at $I_C = 100$ mA, $I_B = 10$ mA | $V_{BE\,sat}$ | 1.1 (< 1.6) | V |
| Collector cutoff current | | | |
| at $V_{CB0} = 20$ V, $T_j = 150\,°C$ | $I_{CB0}$ | 10 (< 30) | µA |
| at $V_{CE} = 20$ V | $I_{CES}$ | 50 (< 400) | nA |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 480 | °C/W |
| Junction to case | $R_{thC}$ | < 150 | °C/W |

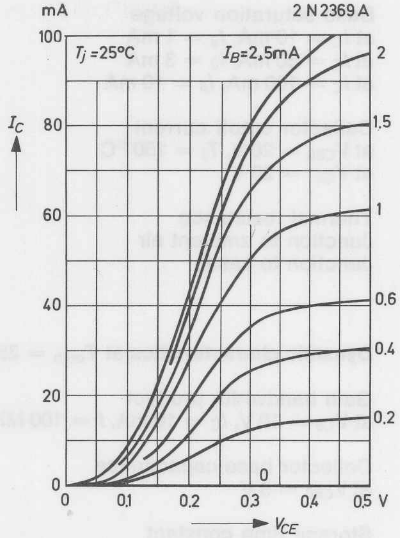
**Dynamic characteristics** at $T_{amb} = 25\,°C$

| | | | |
|---|---|---|---|
| Gain bandwidth product at $V_{CE} = 10$ V, $I_C = 10$ mA, $f = 100$ MHz | $f_T$ | 675 (> 500) | MHz |
| Collector base capacitance at $V_{CB0} = 5$ V | $C_{CB0}$ | 2.3 (< 4) | pF |
| Storage time constant at $I_C = I_{B1} = -I_{B2} = 10$ mA | $\tau_s$ | 6 (< 13) | ns |
| Turn-on time at $I_C = 10$ mA, $I_{B1} = 3$ mA | $t_{on}$ | 9 (< 12) | ns |
| Turn-off time at $I_C = 10$ mA, $I_{B1} = 3$ mA, $-I_{B2} = 1.5$ mA | $t_{off}$ | 13 (< 18) | ns |

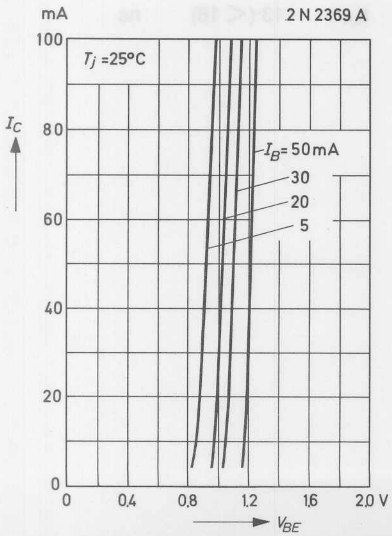
## Common emitter collector characteristics



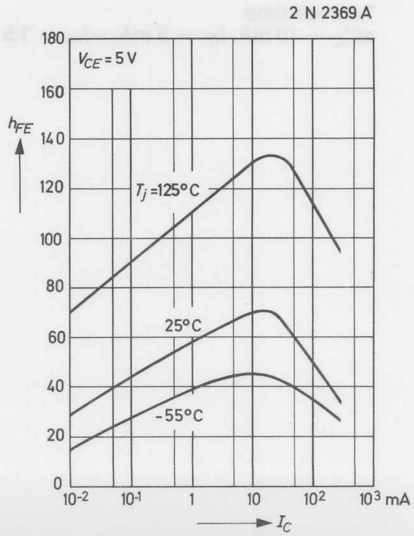

## Common emitter collector characteristics



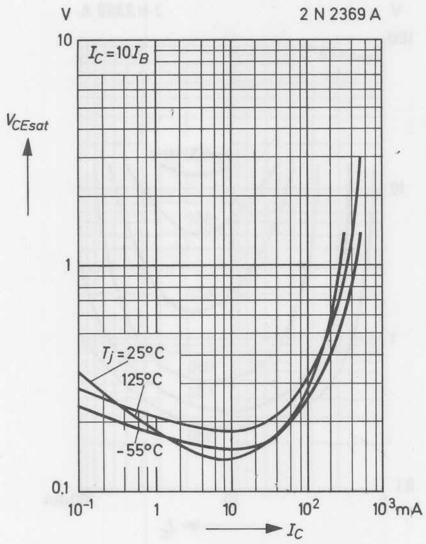

## Collector current versus base emitter voltage



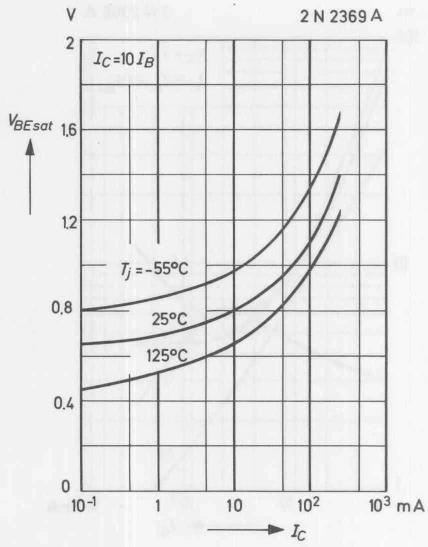

## DC current gain versus collector current



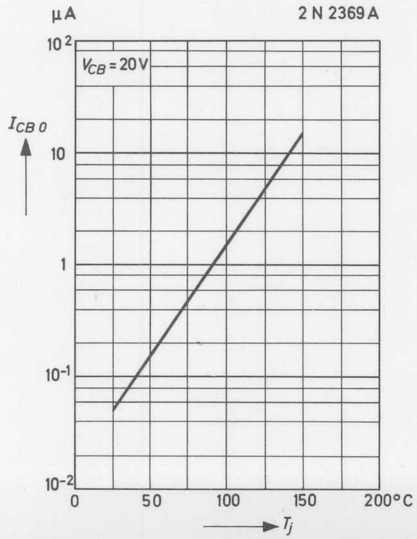
### Collector saturation voltage versus collector current



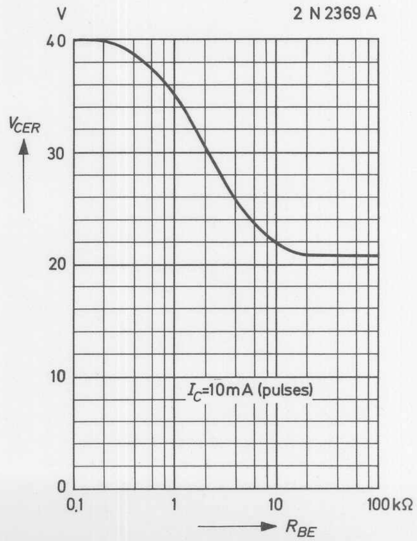

### Base saturation voltage versus collector current



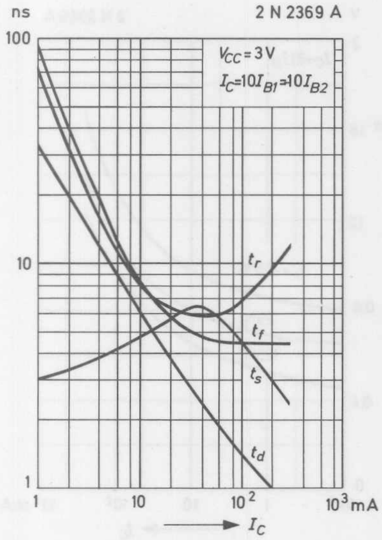

### Collector cutoff current versus junction temperature



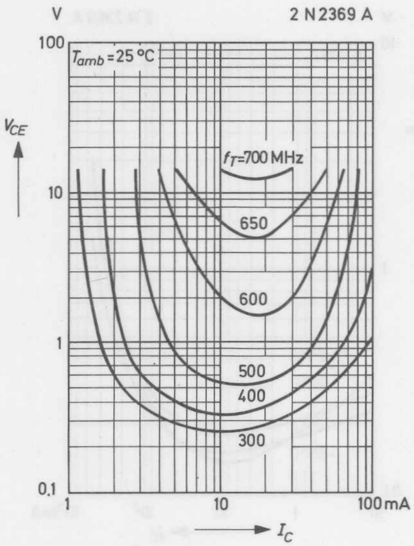

### Admissible collector emitter voltage versus base emitter resistance



**Switching times versus collector current**



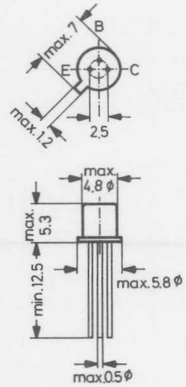

**Contours of constant gain bandwidth product**



# NPN Silicon
# High Frequency Transistors

# BF 120

**NPN Silicon Epitaxial Planar Transistor**
with high collector emitter voltage, intended for use as interstage amplifier between the line frequency integrated circuit TAA 790 and the line output tube in TV sets.




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

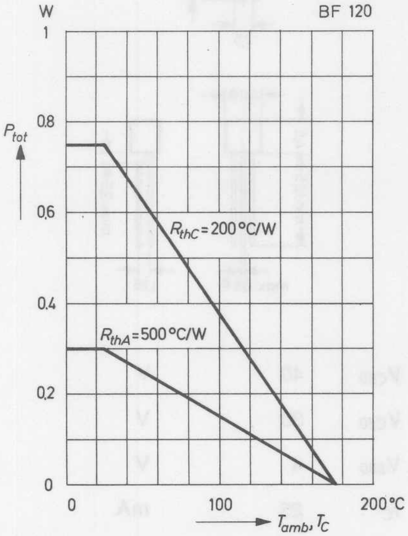
**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector emitter voltage | $V_{CEO}$ | 220 | V |
| Emitter base voltage | $V_{EBO}$ | 5 | V |
| Collector current | $I_C$ | 50 | mA |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 300 | mW |
| at $T_C = 25°\ C$ | $P_{tot}$ | 750 | mW |
| Junction temperature | $T_j$ | 175 | °C |
| Storage temperature range | $T_S$ | –55 ... + 175°C | |

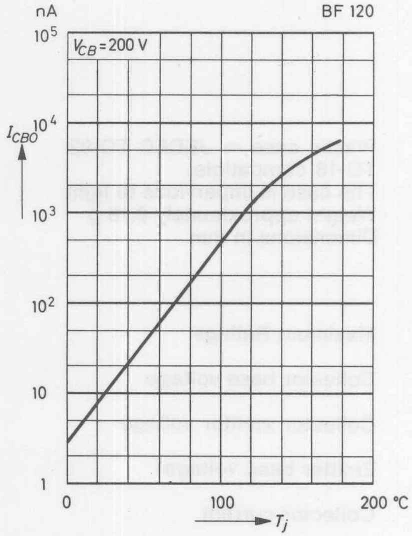
**Characteristics** at $T_j = 25\ °C$

| | | | |
|---|---|---|---|
| DC current gain at $V_{CE} = 10\ V$, $I_C = 10\ mA$ | $h_{FE}$ | $> 20$ | |
| Collector cutoff current at $V_{CB} = 200\ V$ | $I_{CBO}$ | 10 ($< 200$) | nA |
| Collector saturation voltage at $I_C = 10\ mA$, $I_B = 2\ mA$ | $V_{CEsat}$ | $< 2$ | V |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 500$ | °C/W |
| Junction to case | $R_{thC}$ | $< 200$ | °C/W |

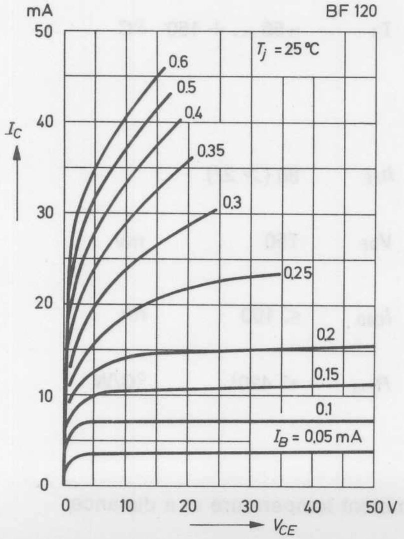
**Admissible power dissipation versus temperature**



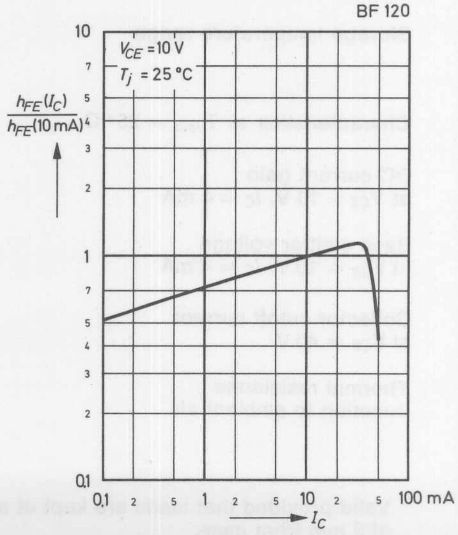

**Collector cutoff current versus junction temperature**




**Common emitter collector characteristics**

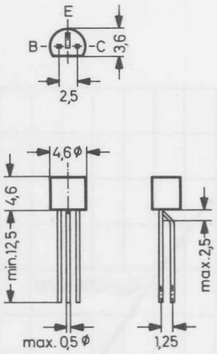



**Relative DC current gain versus collector current**



# BF 198

**NPN Silicon Planar Transistor**
designed for RF applications; low feedback capacitance, especially suited for AGC in emitter-grounded IF stages in TV sets.




Plastic case ≈ JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | V |
| Collector emitter voltage | $V_{CEO}$ | 30 | V |
| Emitter base voltage | $V_{EBO}$ | 4 | V |
| Collector current | $I_C$ | 25 | mA |
| Base current | $I_B$ | 3 | mA |
| Power dissipation at $T_{amb} = 25\,°C$ | $P_{tot}$ | 300[1] | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +150$ | °C |

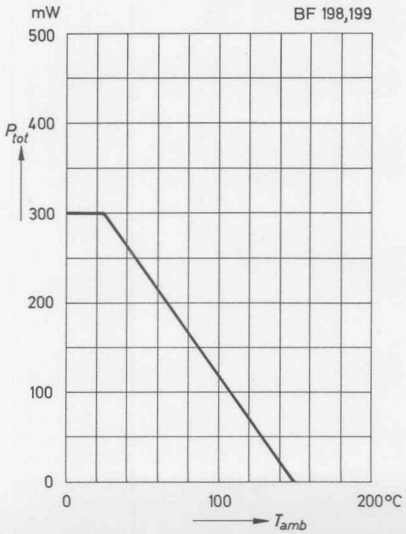
**Characteristics** at $T_{amb} = 25\,°C$

| | | | |
|---|---|---|---|
| DC current gain at $V_{CE} = 10$ V, $I_C = 4$ mA | $h_{FE}$ | 80 (> 27) | |
| Base emitter voltage at $V_{CB} = 10$ V, $I_C = 4$ mA | $V_{BE}$ | 750 | mV |
| Collector cutoff current at $V_{CB} = 40$ V | $I_{CBO}$ | < 100 | nA |
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 420[1] | °C/W |

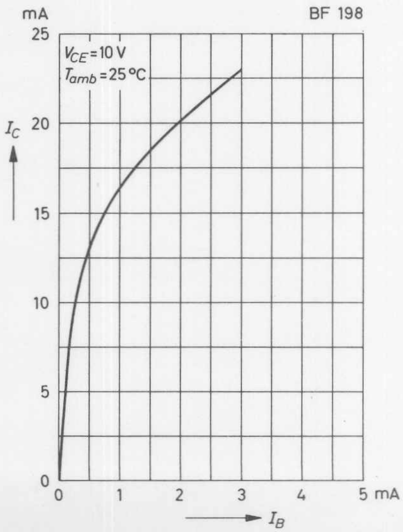
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | |
|---|---|---|---|
| Feedback capacitance<br>at $V_{CB} = 10$ V, $I_C = 1$ mA, $f = 1$ MHz | $-C_{re}$ | 0.22 | pF |
| Gain bandwidth product<br>at $V_{CB} = 10$ V, $I_C = 4$ mA, $f = 100$ MHz | $f_T$ | 400 | MHz |
| Noise figure at $V_{CB} = 10$ V,<br>$I_C = 4$ mA, $f = 35$ MHz, $R_G = 100\ \Omega$ | $F$ | 3 | dB |
| $y$-Parameters (emitter grounded)<br>at $f = 35$ MHz, $V_{CB} = 10$ V, $I_C = 4$ mA | | | |
| Input admittance | $g_{ie}$ | 4.5 | mmho |
| Output admittance | $g_{oe}$ | 35 | μmho |
| Input capacitance | $C_{ie}$ | 40 | pF |
| Output capacitance | $C_{oe}$ | 1.3 | pF |
| Forward transconductance | $\|y_{fe}\|$<br>$\varphi_{fe}$ | 105<br>−20° | mmho |
| Reverse transconductance | $\|y_{re}\|$<br>$\varphi_{re}$ | 45<br>−95° | μmho |

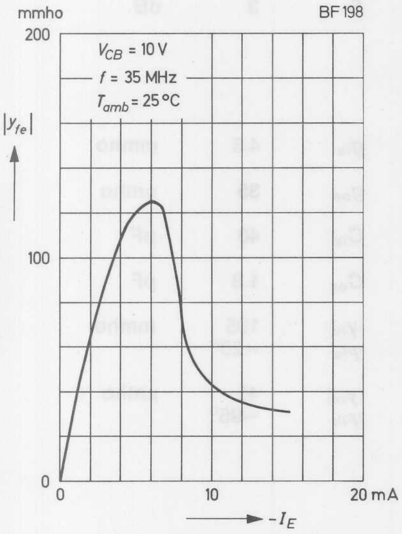
**Admissible power dissipation versus ambient temperature**
(see note on previous page)



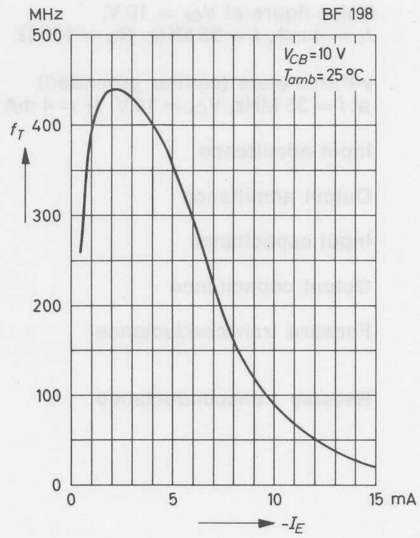

**Collector current versus base current**



**Forward transconductance versus emitter current**

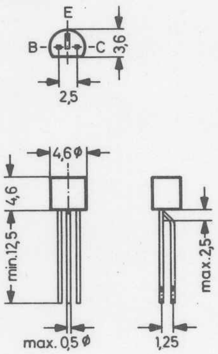



**Gain bandwidth product versus emitter current**



# BF 198

**NPN Silicon Epitaxial Planar Transistor**
designed for RF applications; low feedback capacitance, especially suited for emitter-grounded IF stages in TV sets.




Plastic case ≈ JEDEC TO-92,
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | V |
| Collector emitter voltage | $V_{CEO}$ | 25 | V |
| Emitter base voltage | $V_{EBO}$ | 4 | V |
| Collector current | $I_C$ | 25 | mA |
| Base current | $I_B$ | 2 | mA |
| Power dissipation at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | 300[1] | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +150$ | °C |

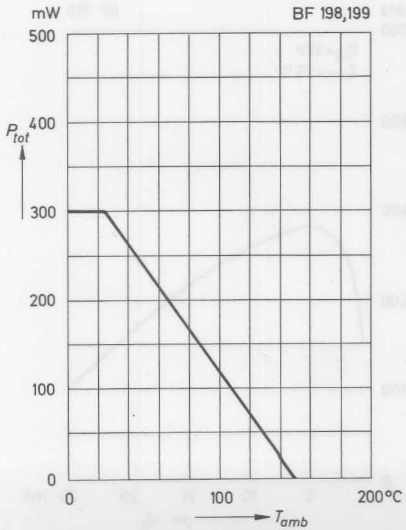
**Characteristics** at $T_{amb} = 25\ ^\circ C$

| | | | |
|---|---|---|---|
| DC current gain at $V_{CE} = 10$ V, $I_C = 7$ mA | $h_{FE}$ | 88 ($>$ 38) | |
| Base emitter voltage at $V_{CB} = 10$ V, $I_C = 7$ mA | $V_{BE}$ | 750 | mV |
| Collector cutoff current at $V_{CB} = 40$ V | $I_{CBO}$ | $<$ 100 | nA |
| Thermal resistance Junction to ambient air | $R_{thA}$ | $<$ 420[1] | °C/W |

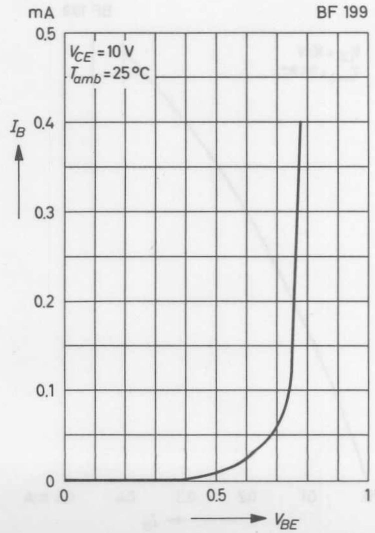
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | |
|---|---|---|---|
| Feedback capacitance<br>at $V_{CB} = 10$ V, $I_C = 1$ mA, $f = 1$ MHz | $-C_{re}$ | 0.32 | pF |
| Gain bandwidth product<br>at $V_{CB} = 10$ V, $I_C = 5$ mA, $f = 100$ MHz | $f_T$ | 550 | MHz |
| $y$-Parameters (emitter grounded)<br>at $f = 35$ MHz, $V_{CB} = 10$ V, $I_C = 7$ mA | | | |
| Input admittance | $g_{ie}$ | 5 | mmho |
| Output admittance | $g_{oe}$ | 75 | µmho |
| Input capacitance | $C_{ie}$ | 45 | pF |
| Output capacitance | $C_{oe}$ | 1.6 | pF |
| Forward transconductance | $\|y_{fe}\|$<br>$\varphi_{fe}$ | 175<br>$-25°$ | mmho |
| Reverse transconductance | $\|y_{re}\|$<br>$\varphi_{re}$ | 65<br>$-95°$ | µmho |

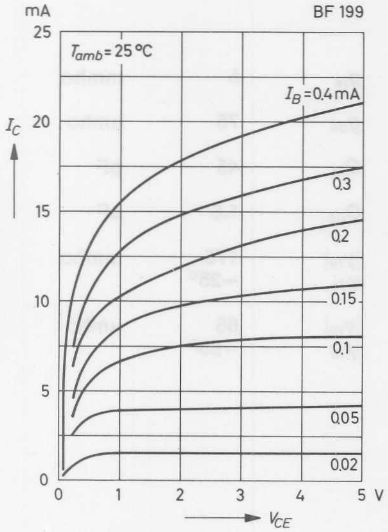
**Admissible power dissipation versus ambient temperature**
(see note on previous page)



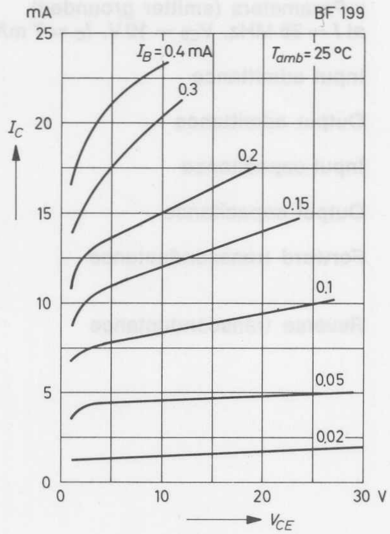

**Common emitter input characteristic**



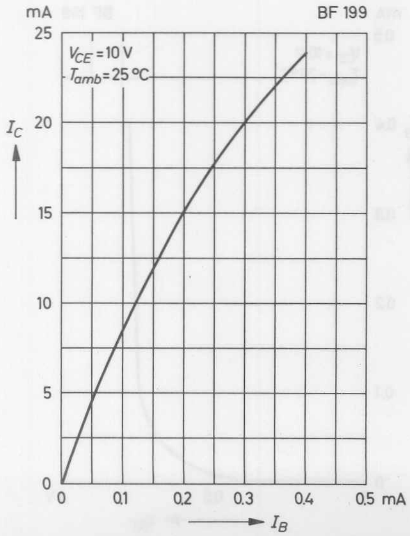
**Common emitter collector characteristics**



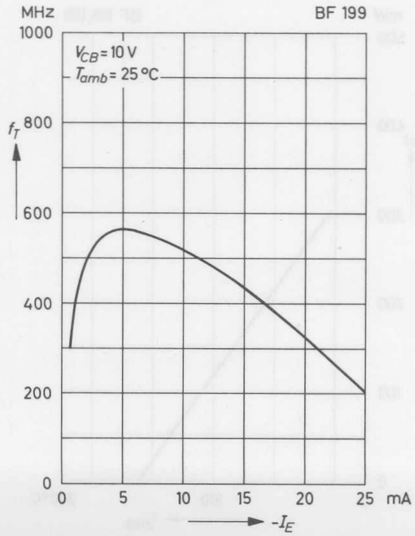

**Common emitter collector characteristics**



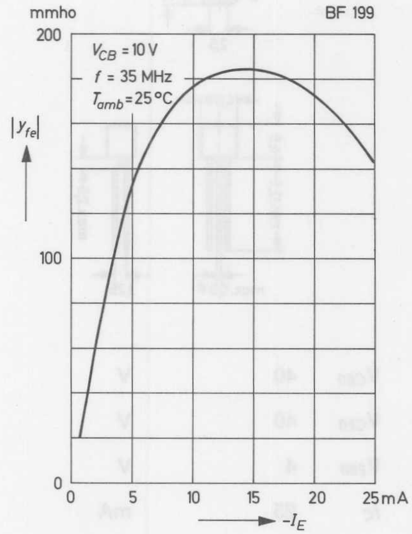

**Collector current versus base current**




**Gain bandwidth product versus emitter current**

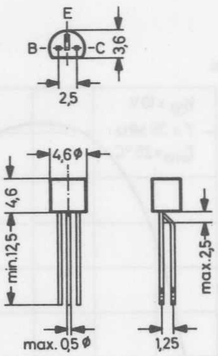


**Forward transconductance versus emitter current**



# BF 240, BF 241

**NPN Silicon Epitaxial Planar Transistors**
designed for emitter-grounded AM and FM amplifier stages




Plastic case ≈ JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $V_{CBO}$ | 40 | V |
| Collector emitter voltage | $V_{CEO}$ | 40 | V |
| Emitter base voltage | $V_{EBO}$ | 4 | V |
| Collector current | $I_C$ | 25 | mA |
| Base current | $I_B$ | 2 | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 300[1] | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | −55 . . . + 150 | °C |

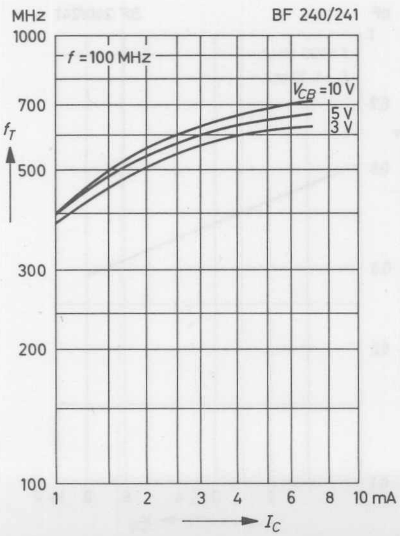
**Characteristics** at $T_{amb} = 25\ °C$

| | | | | |
|---|---|---|---|---|
| DC current gain at $V_{CE} = 10$ V, $I_C = 1$ mA | **BF 240** | $h_{FE}$ | 67 . . . 220 | |
| | **BF 241** | $h_{FE}$ | 36 . . . 125 | |
| Base emitter voltage at $V_{CB} = 10$ V, $I_C = 1$ mA | | $V_{BE}$ | 700 (650 . . . 740) | mV |
| Collector cutoff current at $V_{CB} = 20$ V | | $I_{CBO}$ | < 100 | nA |
| Thermal resistance Junction to ambient air | | $R_{thA}$ | < 420[1] | °C/W |

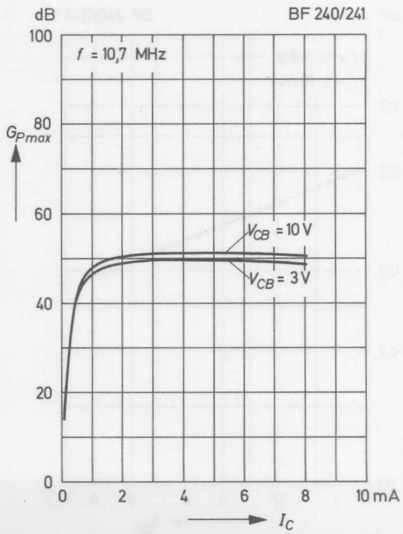
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | | |
|---|---|---|---|---|
| Collector base breakdown voltage at $I_C = 10\ \mu A$ | $V_{(BR)CBO}$ | $> 40$ | | V |
| Collector emitter breakdown voltage at $I_C = 2$ mA | $V_{(BR)CEO}$ | $> 40$ | | V |
| Emitter base breakdown voltage at $I_E = 10\ \mu A$ | $V_{(BR)EBO}$ | $> 4$ | | V |
| | | **BF 240** | **BF 241** | |
| Gain bandwidth product at $V_{CB} = 10$ V, $I_C = 1$ mA, $f = 100$ MHz | $f_T$ | 430 | 400 | MHz |
| Feedback capacitance at $V_{CB} = 10$ V, $I_C = 1$ mA, $f = 1$ MHz | $-C_{re}$ | 0.27 | | pF |
| Noise figure (emitter grounded) at $V_{CB} = 10$ V, $I_C = 1$ mA | | | | |
| $g_s = 5$ mmho, $f = 200$ kHz | $F$ | 1.5 ($< 3.5$) | | dB |
| $y_s = (6.6 - j3.3)$ mmho, $f = 100$ MHz | $F$ | 1.6 | | dB |
| Output admittance | | | | |
| at $V_{CB} = 10$ V, $I_C = 1$ mA, $f = 10.7$ MHz | $g_{oe}$ | $< 10.5$ | | µmho |
| at $V_{CB} = 10$ V, $I_C = 1$ mA, $f = 470$ kHz | $g_{oe}$ | $< 8.3$ | | µmho |

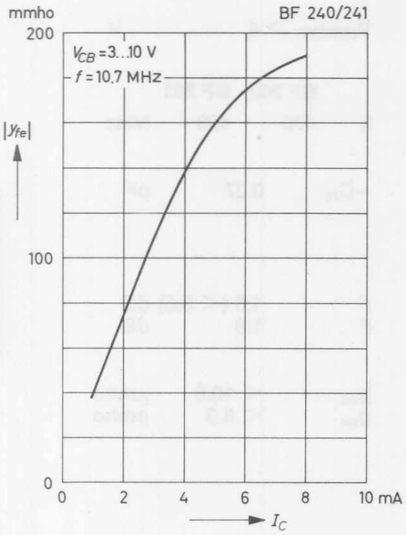
**Gain bandwidth product versus collector current**



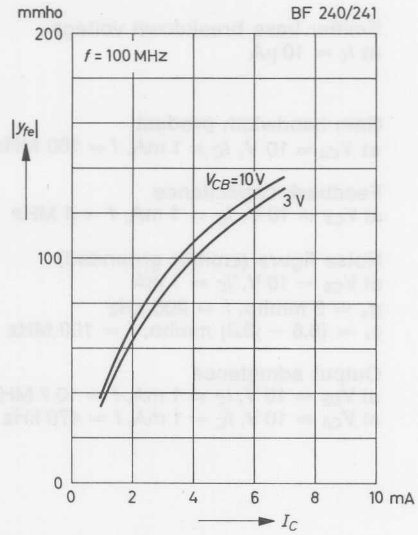

**Max. available power gain versus collector current**



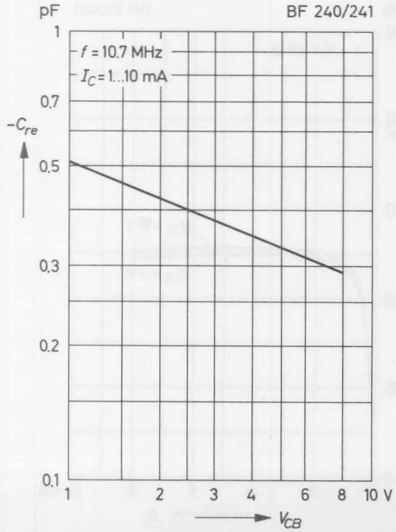
**Forward transconductance at 10.7 MHz versus collector current**



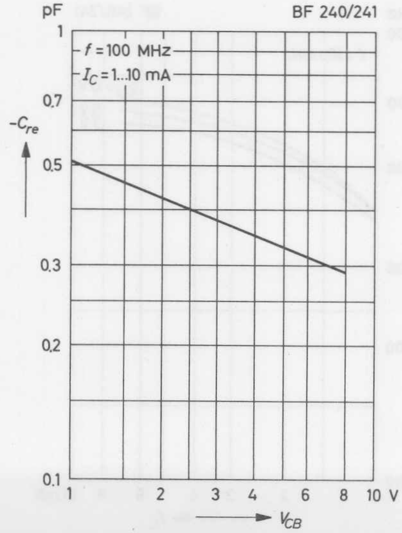

**Forward transconductance at 100 MHz versus collector current**



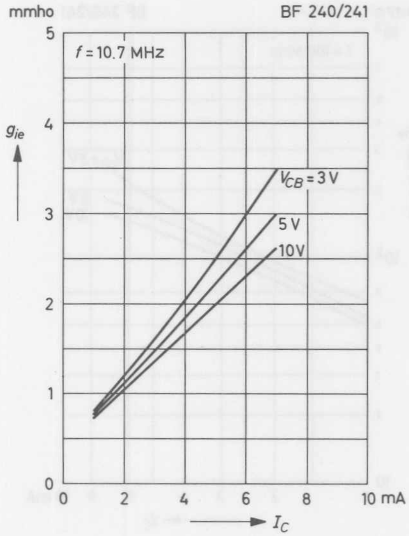

**Feedback capacitance at 10.7 MHz versus collector base voltage**



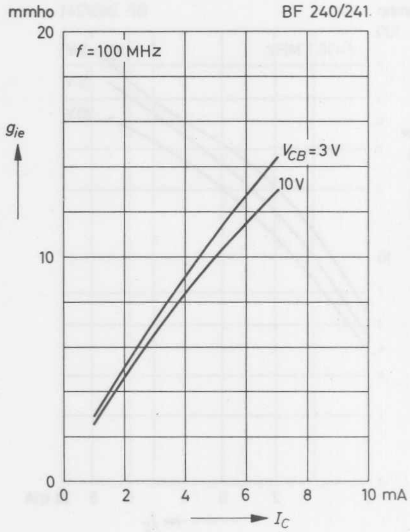

**Feedback capacitance at 100 MHz versus collector base voltage**



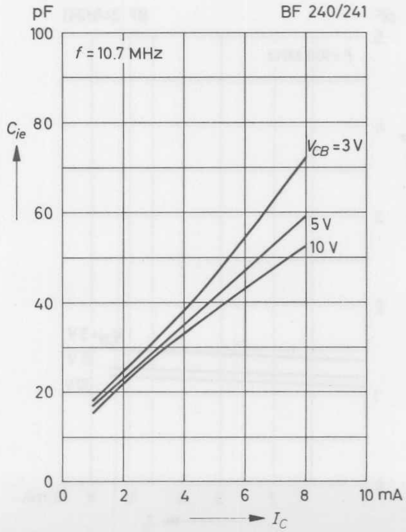
**Input admittance at 10.7 MHz versus collector current**



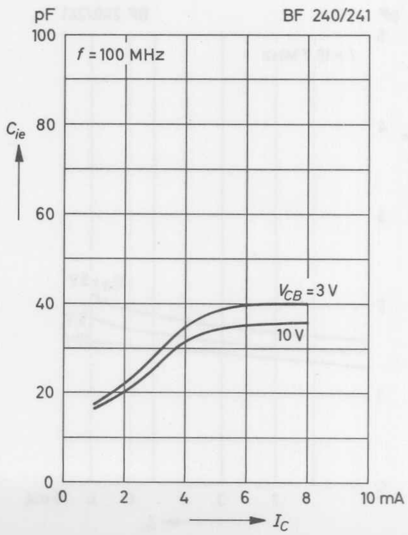

**Input admittance at 100 MHz versus collector current**



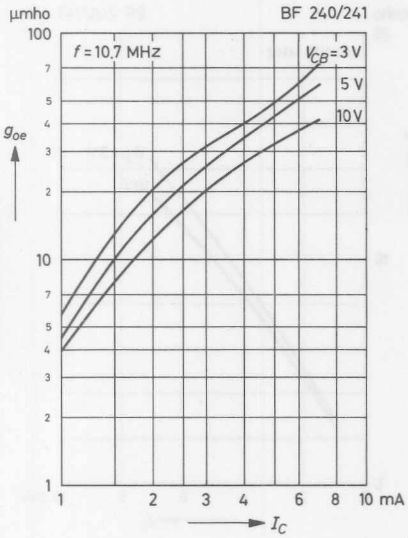

**Input capacitance at 10.7 MHz versus collector current**



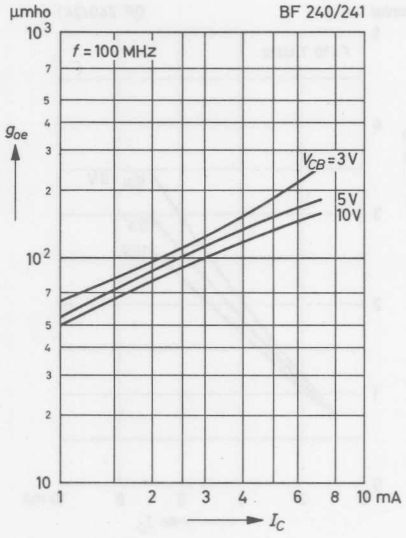

**Input capacitance at 100 MHz versus collector current**



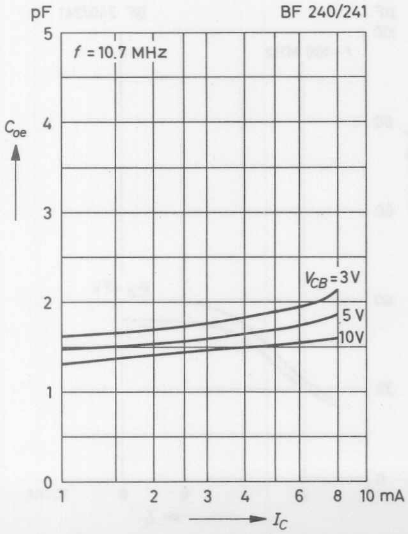
**Output admittance at 10.7 MHz versus collector current**



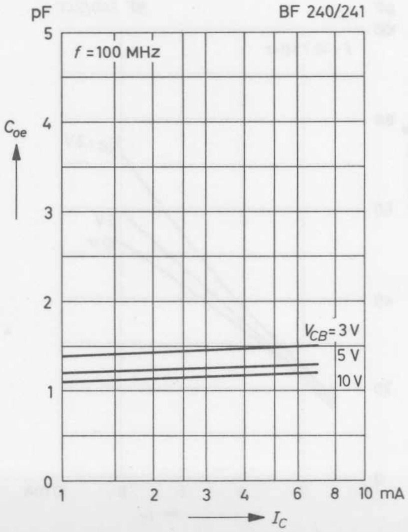

**Output admittance at 100 MHz versus collector current**




**Output capacitance at 10.7 MHz versus collector current**




**Output capacitance at 100 MHz versus collector current**

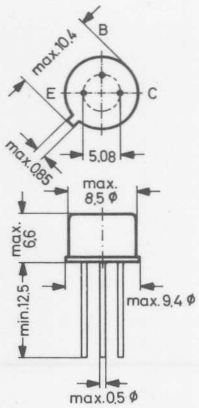


# PNP Silicon Transistors

# BC 160, BC 161

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications

These types are subdivided into three groups, -6, -10 and -16, according to their DC current gain. As complementary types the NPN transistors BC 140 and BC 141 are recommended.




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

| **Maximum Ratings** | | **BC 160** | **BC 161** | |
|---|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 40 | 60 | V |
| Collector emitter voltage | $-V_{CEO}$ | 40 | 60 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | 5 | V |
| Collector current | $-I_C$ | 1 | | A |
| Base current | $-I_B$ | 0.1 | | A |
| Power dissipation | | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.75 | | W |
| at $T_C = 60\ °C$, $-V_{CE} < 8\ V$ | $P_{tot}$ | 3.2 | | W |
| Junction temperature | $T_j$ | 175 | | °C |
| Storage temperature range | $T_S$ | $-55\ldots+175$ | | °C |

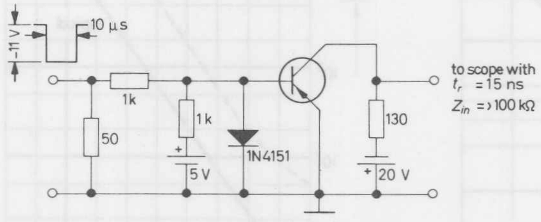
| **Characteristics** at $T_j = 25\ °C$ | | **BC 160-6**<br>**BC 161-6** | **BC 160-10**<br>**BC 161-10** | **BC 160-16**<br>**BC 161-16** | |
|---|---|---|---|---|---|
| DC current gain | | | | | |
| at $-V_{CE} = 1\ V$, $-I_C = 0.1\ mA$ | $h_{FE}$ | 46 | 80 | 120 | |
| at $-V_{CE} = 1\ V$, $-I_C = 100\ mA$ | $h_{FE}$ | 63<br>(40...100) | 100<br>(63...160) | 160<br>(100...250) | |
| at $-V_{CE} = 1\ V$, $-I_C = 1\ A$ | $h_{FE}$ | 15 | 20 | 30 | |
| Collector saturation voltage<br>at $-I_C = 1\ A$, $-I_B = 100\ mA$ | $-V_{CE\,sat}$ | | 0.6 (< 1) | | V |
| Base emitter voltage<br>at $-V_{CE} = 1\ V$, $-I_C = 1\ A$ | $-V_{BE}$ | | 1.0 (< 1.7) | | V |

| | | BC 160 | BC 161 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $-V_{CE} = 40$ V | $-I_{CES}$ | 10 (< 100) | – | nA |
| at $-V_{CE} = 60$ V | $-I_{CES}$ | – | 10 (< 100) | nA |
| at $-V_{CE} = 40$ V, $T_j = 150$ °C | $-I_{CES}$ | 10 (< 100) | – | µA |
| at $-V_{CE} = 60$ V, $T_j = 150$ °C | $-I_{CES}$ | – | 10 (< 100) | µA |
| Collector emitter breakdown voltage | | | | |
| at $-I_C = 0.1$ mA | $-V_{(BR)CES}$ | > 40 | > 60 | V |
| at $-I_C = 50$ mA (pulsed 200 µs, 1%) | $-V_{(BR)CEO}$ | > 40 | > 60 | V |
| Emitter base breakdown voltage at $-I_C = 0.1$ mA | $-V_{(BR)EBO}$ | > 5 | > 5 | V |
| Gain bandwidth product at $-V_{CE} = 10$ V, $-I_C = 50$ mA, $f = 20$ MHz | $f_T$ | > 50 | | MHz |
| Collector base capacitance at $-V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | < 30 | | pF |
| Emitter base capacitance at $-V_{EBO} = 0.5$ V, $f = 1$ MHz | $C_{EBO}$ | < 180 | | pF |
| Thermal resistance | | | | |
| Junction to case | $R_{thC}$ | < 35 | | °C/W |
| Junction to ambient air | $R_{thA}$ | < 200 | | °C/W |

**Switching Times** at $-I_C = 100$ mA, $-I_{B1} \approx I_{B2} \approx 5$ mA

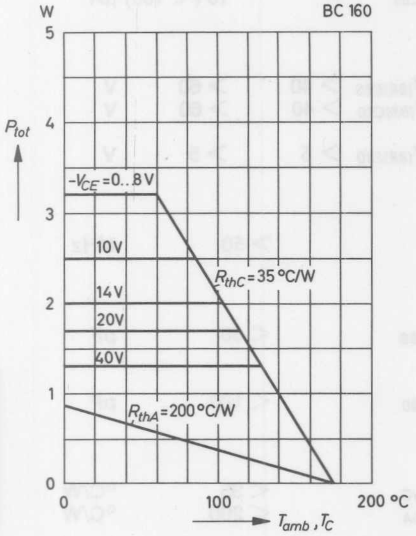
| | | | |
|---|---|---|---|
| Turn-on time | $t_{on}$ | < 500 | ns |
| Turn-off time | $t_{off}$ | < 650 | ns |

**Test Circuit for Switching Times**

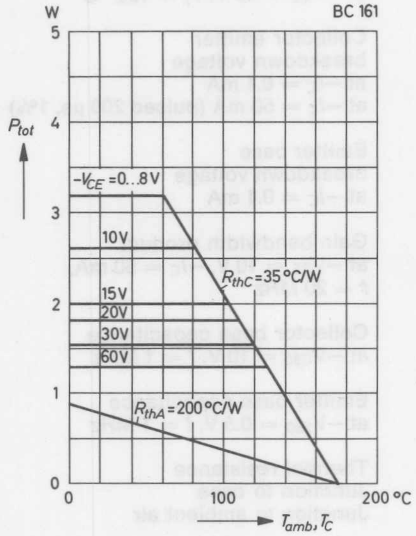



Rise time and fall time of input voltage < 15 ns, generator impedance 50 Ω.

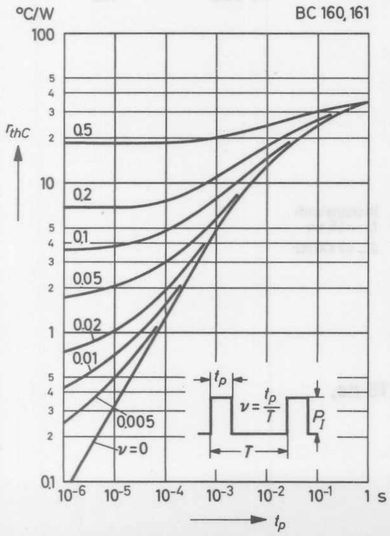
**Admissible power dissipation versus temperature**



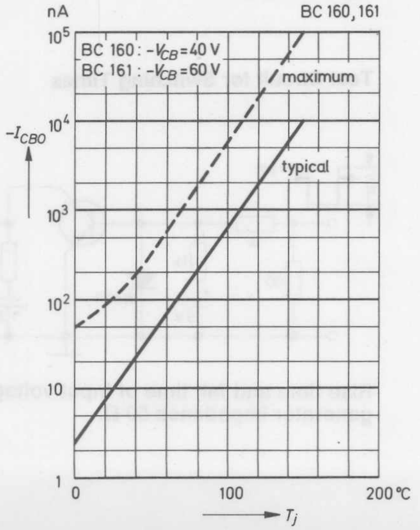

**Admissible power dissipation versus temperature**



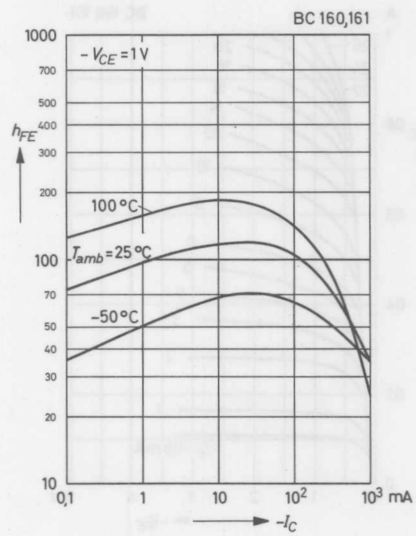

**Pulse thermal resistance versus pulse duration**



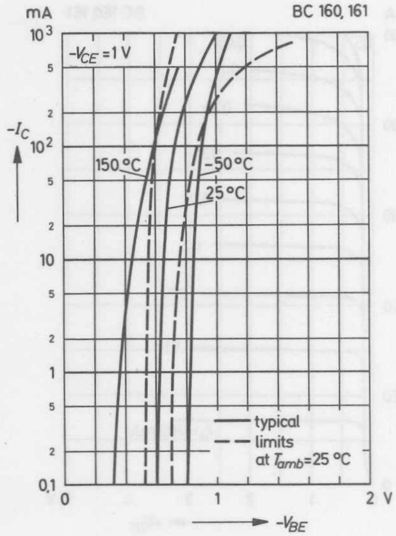

**Collector cutoff current versus junction temperature**



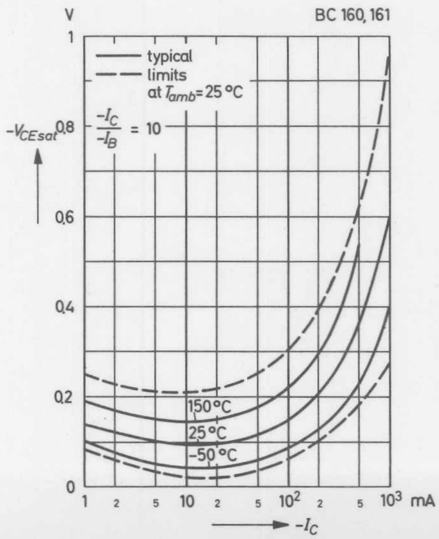
**DC current gain versus collector current**



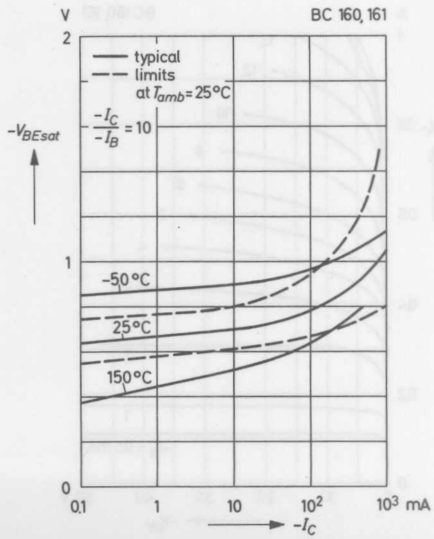

**Collector current versus base emitter voltage**



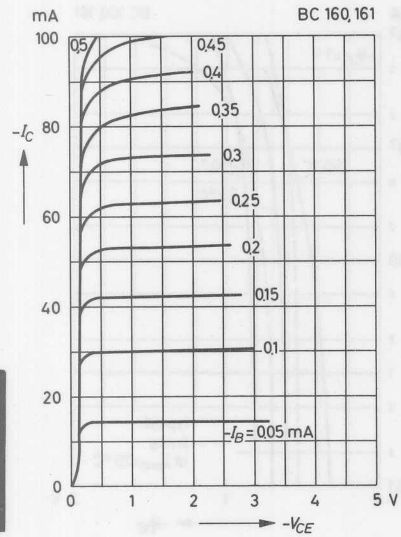

**Collector saturation voltage versus collector current**



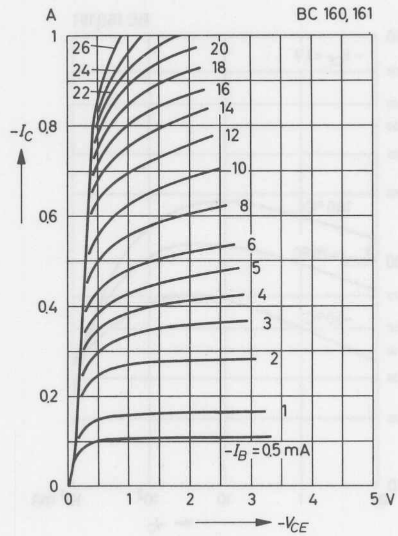

**Base saturation voltage versus collector current**



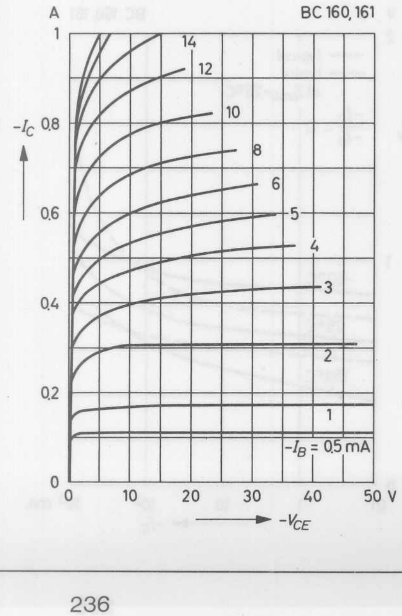
**Common emitter collector characteristics**



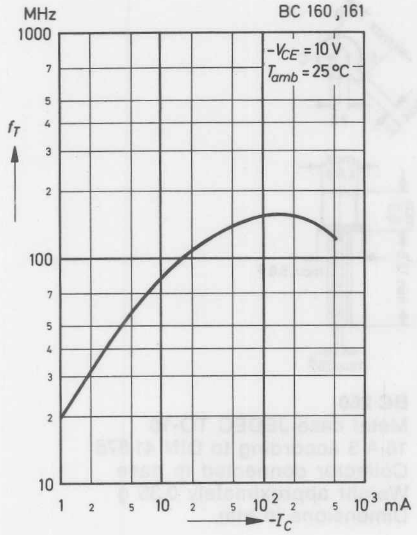

**Common emitter collector characteristics**



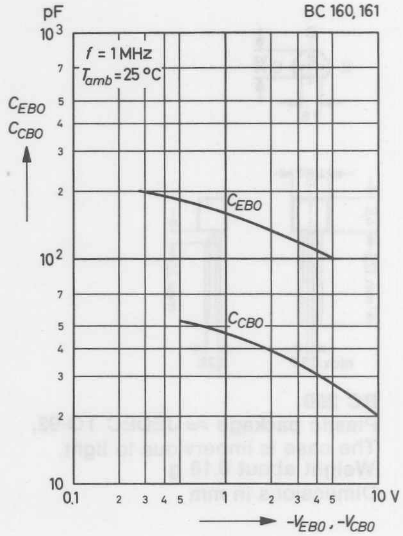

**Common emitter collector characteristics**



**Gain bandwidth product versus collector current**



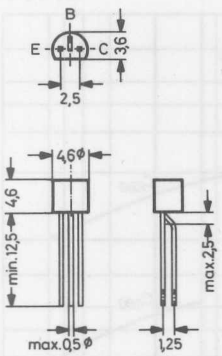

**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



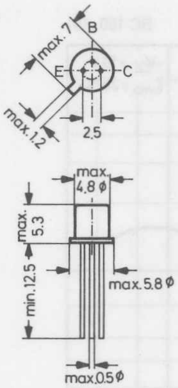
# BC 250, BC 260

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications

The transistors are subdivided into three groups A, B and C according to their DC current gain.




**BC 250**
Plastic package ≈ JEDEC TO-92,
The case is impervious to light.
**Weight about 0.18 g**
Dimensions in mm




**BC 260**
Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

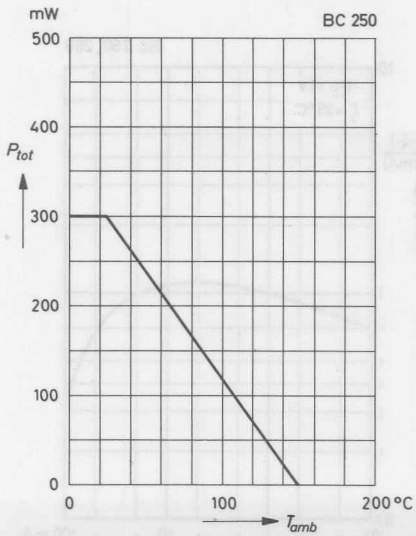
| | | | | |
|---|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 20 | | V |
| Collector emitter voltage | $-V_{CEO}$ | 20 | | V |
| Emitter base voltage | $-U_{EBO}$ | 5 | | V |
| Collector current | $-I_C$ | 100 | | mA |
| | | **BC 250** | **BC 260** | |
| Power dissipation at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | 300[1] | 300 | mW |
| Junction temperature | $T_j$ | 150 | 175 | °C |
| Storage temperature range | $T_S$ | –55...+150 | –55...+175 | °C |

[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

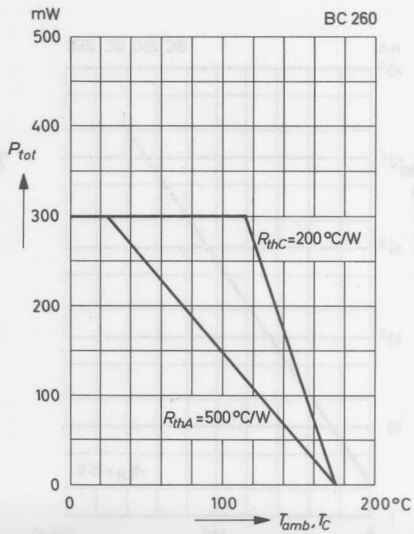
| Characteristics at $T_j = 25\ ^\circ C$ | | BC 250 A<br>BC 260 A | BC 250 B<br>BC 260 B | BC 250 C<br>BC 260 C |
|---|---|---|---|---|
| DC current gain<br>at $-V_{CE} = 1$ V, $-I_C = 1$ mA | $h_{FE}$ | 35...100 | 80...250 | 200...600 |
| Collector saturation voltage<br>at $-I_C = 30$ mA, $-I_B = 3$ mA | $-V_{CE\,sat}$ | 0.4 | | V |
| Collector cutoff current<br>at $-V_{CB} = 15$ V | $-I_{CB0}$ | $< 100$ | | nA |
| Emitter cutoff current<br>at $-V_{EB} = 4$ V | $-I_{EB0}$ | $< 100$ | | nA |
| Gain bandwidth product<br>at $-V_{CE} = 5$ V, $-I_C = 10$ mA,<br>$f = 100$ MHz | $f_T$ | 180 | | MHz |
| Collector base capacitance<br>at $-V_{CB0} = 10$ V, $f = 1$ MHz | $C_{CB0}$ | 3 | | pF |
| Emitter base capacitance<br>at $-V_{EB0} = 0.5$ V, $f = 1$ MHz | $C_{EB0}$ | 12 | | pF |

| | | BC 250 | BC 260 | |
|---|---|---|---|---|
| Thermal resistance | | | | |
| Junction to ambient air | $R_{thA}$ | $< 420$[1] | $< 500$ | °C/W |
| Junction to case | $R_{thC}$ | | $< 200$ | °C/W |

**Admissible power dissipation versus ambient temperature**[1]

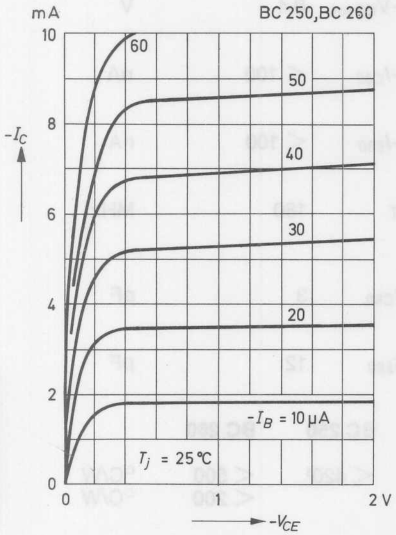



**Admissible power dissipation versus temperature**

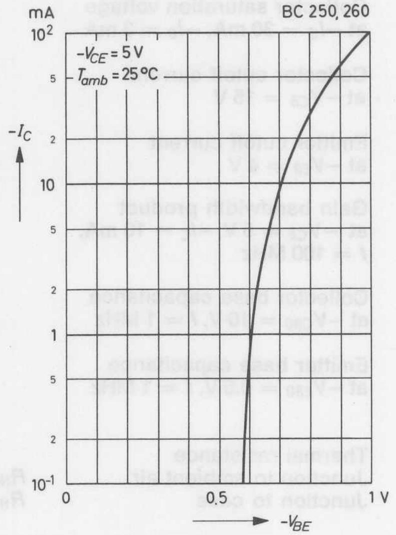



[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

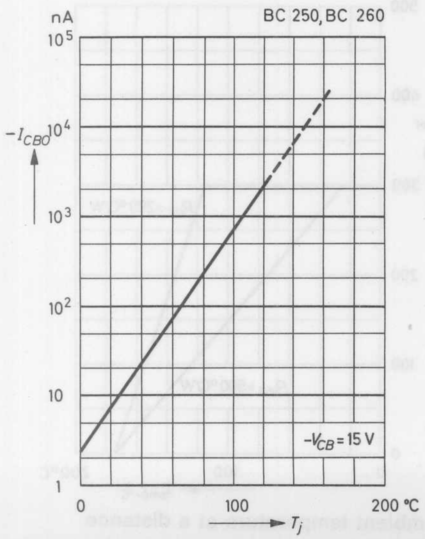
**Common emitter collector characteristics**



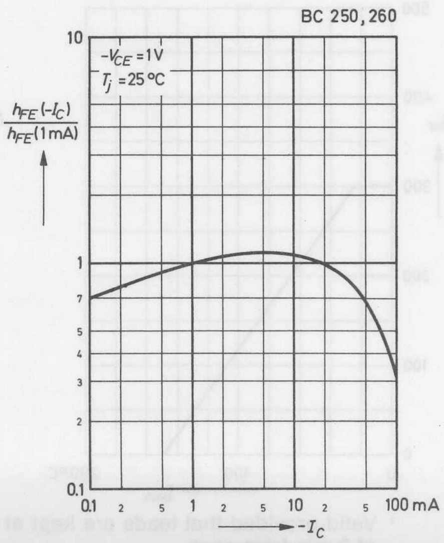

**Collector current versus base emitter voltage**




**Collector cutoff current versus junction temperature**

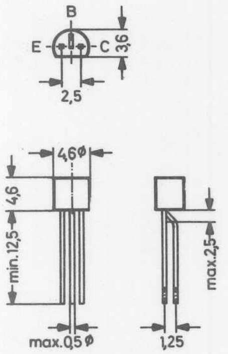


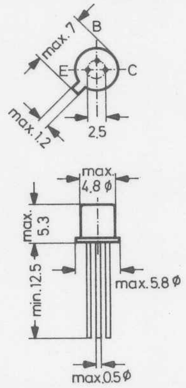

**Relative DC current gain versus collector current**



**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications

The transistors are subdivided into three groups A, B and C according to their current gain. BC 256 and BC 266 are available in groups A and B only. BC 253, BC 263 and BC 309 are low noise types.




**BC 251, BC 252, BC 253, BC 256, BC 307, BC 308, BC 309**

Plastic package ≈ JEDEC TO-92, TO-18 compatible.
The case is impervious to light
Weight approximately 0.18 g
Dimensions in mm

**BC 261, BC 262, BC 263, BC 266**

Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | BC 251<br>BC 261<br>BC 307 | BC 252<br>BC 253<br>BC 262<br>BC 263<br>BC 308<br>BC 309 | BC 256<br>BC 266 | |
|---|---|---|---|---|---|
| Collector emitter voltage | $-V_{CES}$ | 50 | 30 | 64 | V |
| Collector emitter voltage | $-V_{CEO}$ | 45 | 25 | 64 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | 5 | 5 | V |
| Collector current | $-I_C$ | 100 | 100 | 100 | mA |
| Peak collector current | $-I_{CM}$ | 200 | 200 | 200 | mA |
| Base current | $-I_B$ | 50 | 50 | 50 | mA |
| Base peak current | $-I_{BM}$ | 100 | 100 | 100 | mA |

| | | TO-92 | TO-18 | |
|---|---|---|---|---|
| Power dissipation at $T_{amb}$ = 25 °C | $P_{tot}$ | 300[1] | 300 | mW |
| Junction temperature | $T_j$ | 150 | 175 | °C |
| Storage temperature range | $T_S$ | –55...+150 | –55...+175 | °C |

[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

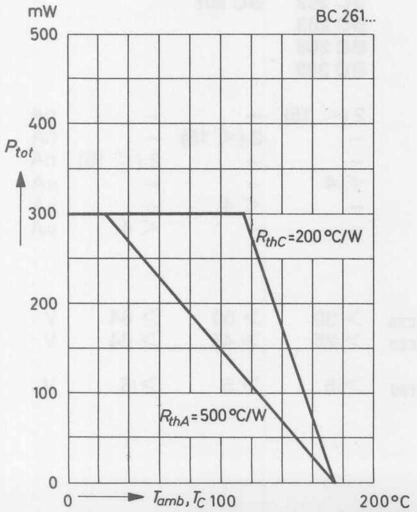
| Characteristics at $T_{amb}$ = 25 °C<br>$h$-Parameters at $-V_{CE}$ = 5 V,<br>$-I_C$ = 2 mA, $f$ = 1 kHz | | Current gain group<br>A | <br>B | <br>C | |
|---|---|---|---|---|---|
| Small signal current gain | $h_{fe}$ | 220<br>(125..260) | 330<br>(240..500) | 600<br>(450..900) | |
| Input impedance | $h_{ie}$ | 2.7<br>(1.6..4.5) | 4.5<br>(3.2...8.5) | 8.7<br>(6...15) | kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 35 (< 60) | 60 (< 110) | μmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |
| DC current gain | | | | | |
| at $-V_{CE}$ = 5 V, $-I_C$ = 0.01 mA | $h_{FE}$ | 90 | 150 | 270 | |
| at $-V_{CE}$ = 5 V, $-I_C$ = 2 mA | $h_{FE}$ | 170 | 290 | 500 | |
| at $-V_{CE}$ = 5 V, $-I_C$ = 100 mA | $h_{FE}$ | 120[1] | 200[1] | 400[1] | |
| Collector saturation voltage | | | | | |
| at $-I_C$ = 10 mA, $-I_B$ = 0.5 mA | $-V_{CE\,sat}$ | | < 0.3 | | V |
| at $-I_C$ = 100 mA, $-I_B$ = 5 mA | $-V_{CE\,sat}$ | | 0.5[1] | | V |
| Base saturation voltage | | | | | |
| at $-I_C$ = 10 mA, $-I_B$ = 0.5 mA | $-V_{BE\,sat}$ | | 0.7 | | V |
| at $-I_C$ = 100 mA, $-I_B$ = 5 mA | $-V_{BE\,sat}$ | | 0.85[1] | | V |
| Base emitter voltage | | | | | |
| at $-V_{CE}$ = 5 V, $-I_C$ = 0.1 mA | $-V_{BE}$ | | 0.57 | | V |
| at $-V_{CE}$ = 5 V, $-I_C$ = 2 mA | $-V_{BE}$ | | 0.62<br>(0.55...0.7) | | V |
| at $-V_{CE}$ = 5 V, $-I_C$ = 100 mA | $-V_{BE}$ | | 0.8 | | V |
| | | **BC 252**<br>**BC 253**<br>**BC 262**<br>**BC 263**<br>**BC 308**<br>**BC 309** | **BC 251**<br>**BC 261**<br>**BC 307** | **BC 256**<br>**BC 266** | |
| Collector cutoff current | | | | | |
| at $-V_{CE}$ = 25 V | $-I_{CES}$ | 2 (< 15) | – | – | nA |
| at $-V_{CE}$ = 45 V | $-I_{CES}$ | – | 2 (< 15) | – | nA |
| at $-V_{CE}$ = 64 V | $-I_{CES}$ | – | – | 2 (< 15) | nA |
| at $-V_{CE}$ = 25 V, $T_j$ = 125 °C | $-I_{CES}$ | < 4 | – | – | μA |
| at $-V_{CE}$ = 45 V, $T_j$ = 125 °C | $-I_{CES}$ | – | < 4 | – | μA |
| at $-V_{CE}$ = 64 V, $T_j$ = 125 °C | $-I_{CES}$ | – | – | < 4 | μA |
| Collector emitter breakdown voltage | | | | | |
| at $-I_{CES}$ = 10 μA | $-V_{(BR)CES}$ | > 30 | > 50 | > 64 | V |
| at $-I_{CE0}$ = 2 mA | $-V_{(BR)CE0}$ | > 25 | > 45 | > 64 | V |
| Emitter base breakdown voltage at $-I_{EB0}$ = 10 μA | $-V_{(BR)EB0}$ | > 5 | > 5 | > 5 | V |

[1] not valid for BC 253, BC 263 and BC 309

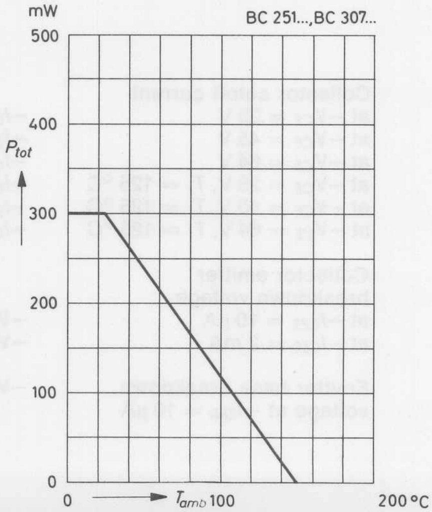
| | | | |
|---|---|---|---|
| Gain bandwidth product at $-V_{CE} = 5$ V, $-I_C = 10$ mA, $f = 50$ MHz | $f_T$ | 130 | MHz |
| Collector base capacitance at $-V_{CB0} = 10$ V, $f = 1$ MHz | $C_{CB0}$ | $< 6$ | pF |
| Emitter base capacitance at $-V_{EB0} = 0.5$ V, $f = 1$ MHz | $C_{EB0}$ | 12 | pF |
| **BC 251, BC 252, BC 256, BC 261, BC 262, BC 266, BC 307, BC 308:** | | | |
| Noise figure at $-V_{CE} = 5$ V, $-I_C = 0.2$ mA, $R_G = 2$ kΩ, $f = 1$ kHz | $F$ | $< 10$ | dB |
| **BC 253, BC 263 and BC 309:** | | | |
| Noise figure at $-V_{CE} = 5$ V, $-I_C = 0.2$ mA, $R_G = 2$ kΩ, $f = 1$ kHz | $F$ | $< 4$ | dB |
| Noise figure at $-V_{CE} = 5$ V, $-I_C = 0.2$ mA, $R_G = 2$ kΩ, $f = 30$ Hz . . . 15 kHz | $F$ | 2 ($< 4$) | dB |

| Thermal resistance | | TO-92 | TO-18 | |
|---|---|---|---|---|
| Junction to case | $R_{thC}$ | – | $< 200$ | °C/W |
| Junction to ambient air | $R_{thA}$ | $< 420$[1] | $< 500$ | °C/W |

**Admissible power dissipation versus temperature**

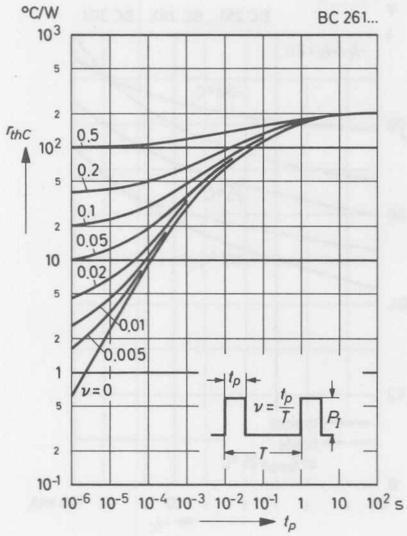



**Admissible power dissipation versus ambient temperature**[1]

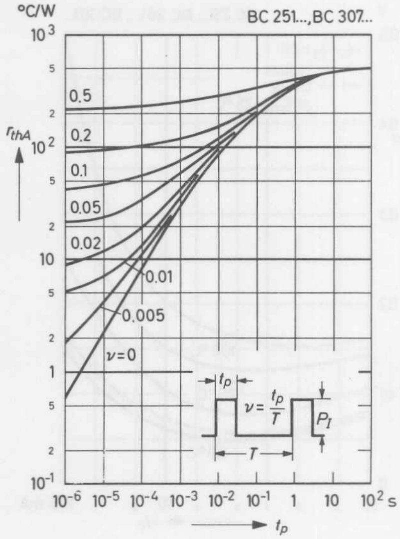



[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

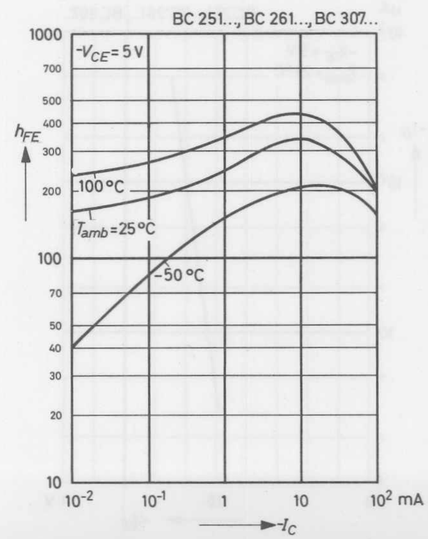
**Pulse thermal resistance versus pulse duration**



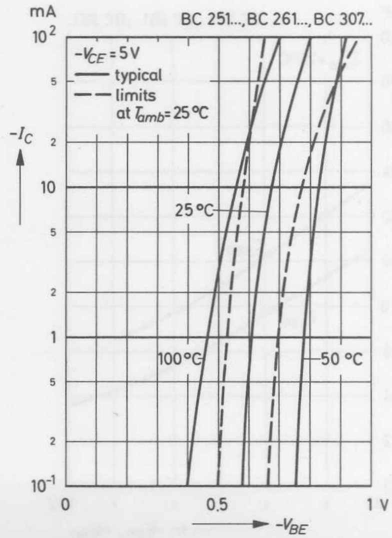

**Pulse thermal resistance versus pulse duration**
(see note on page 244)



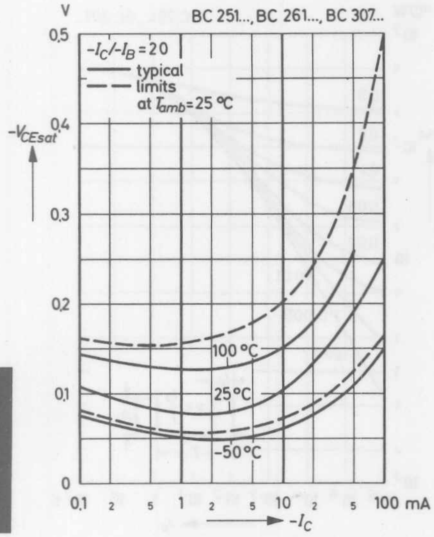

**DC current gain versus collector current**



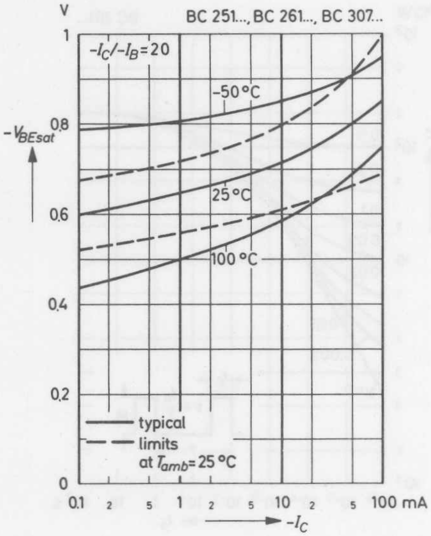

**Collector current versus base emitter voltage**



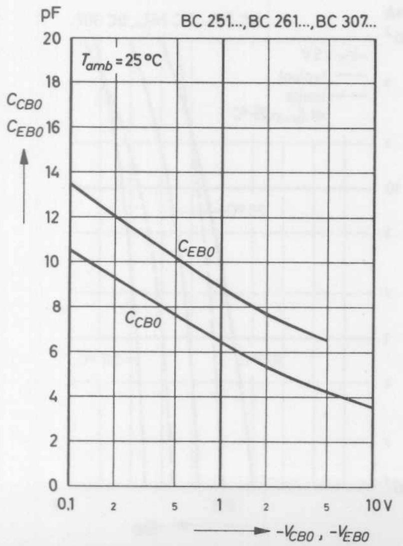
**Collector saturation voltage versus collector current**



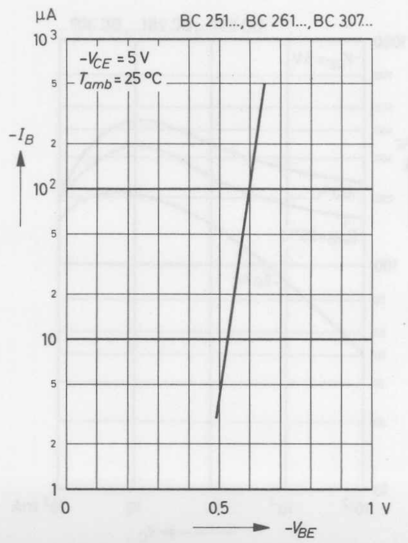

**Base saturation voltage versus collector current**



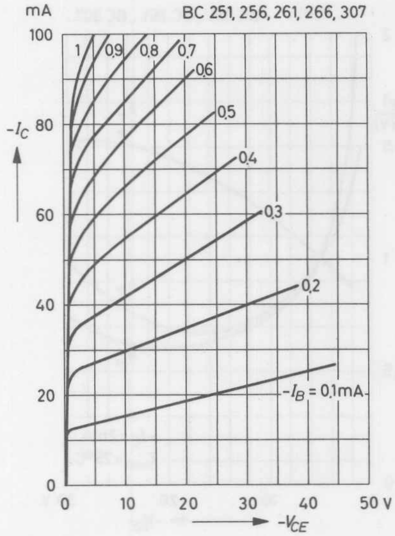

**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



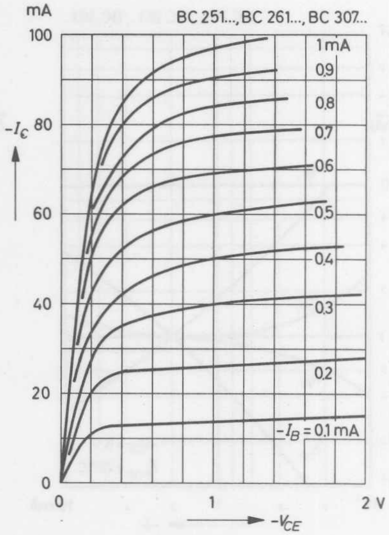

**Common emitter input characteristic**



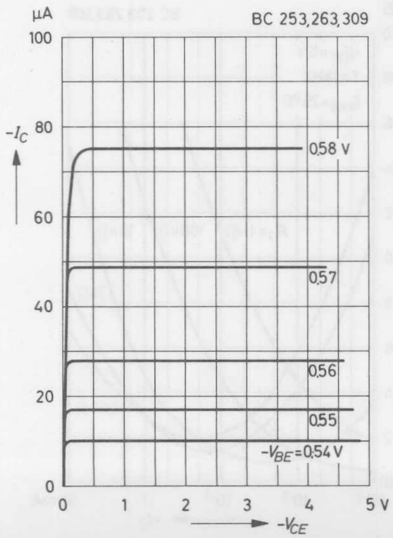
**Common emitter collector characteristics**



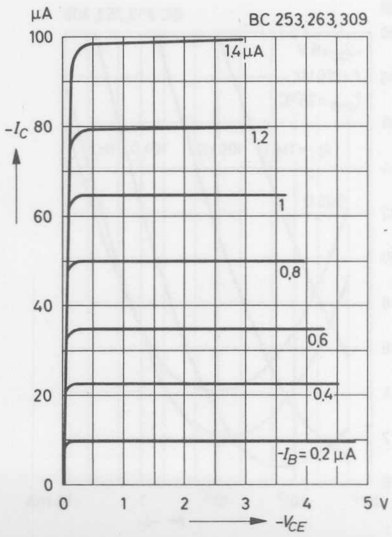

**Common emitter collector characteristics**



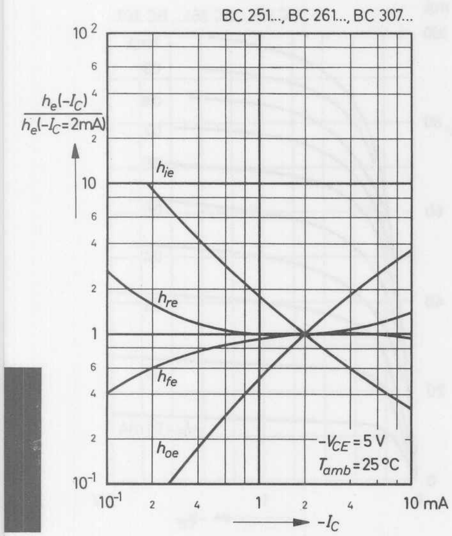

**Common emitter collector characteristics**



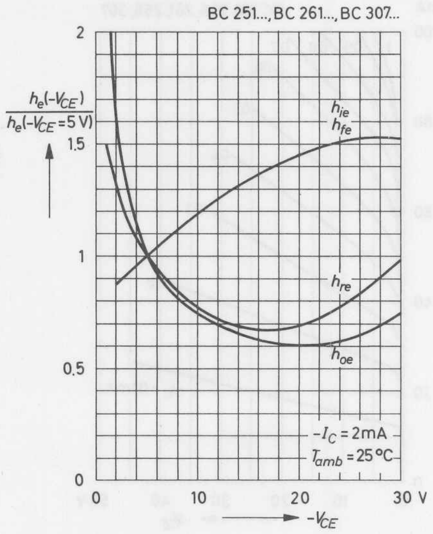

**Common emitter collector characteristics**



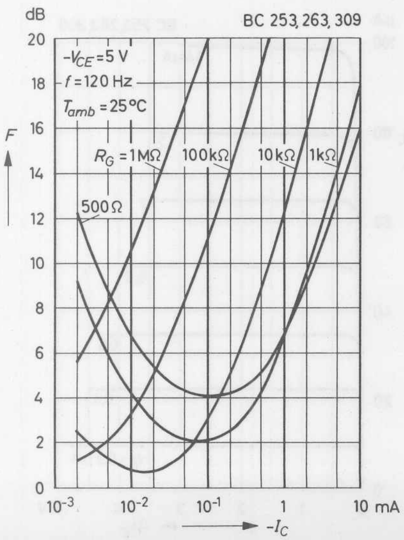
**Relative *h*-parameters versus collector current**



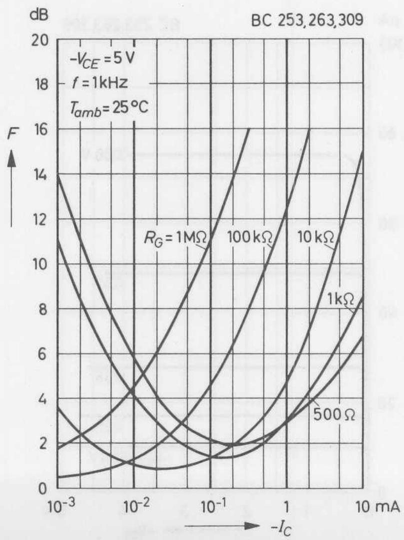

**Relative *h*-parameters versus collector emitter voltage**



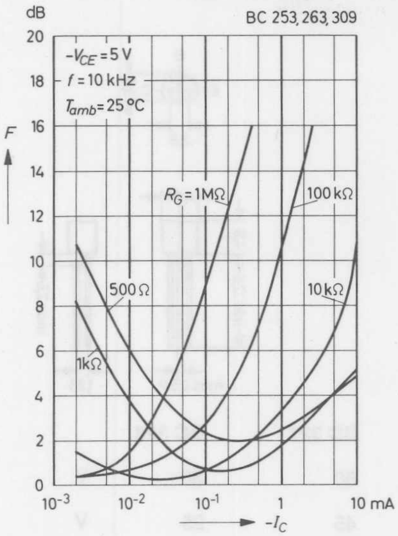

**Noise figure versus collector current**



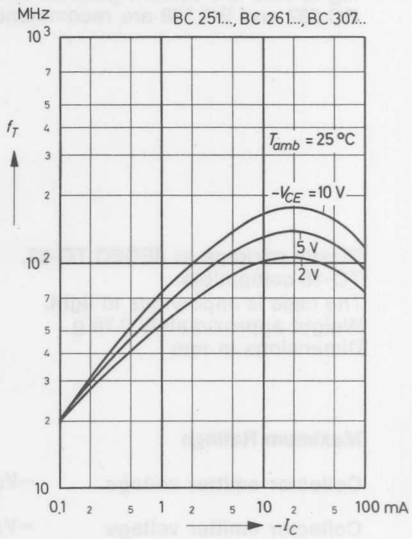

**Noise figure versus collector current**



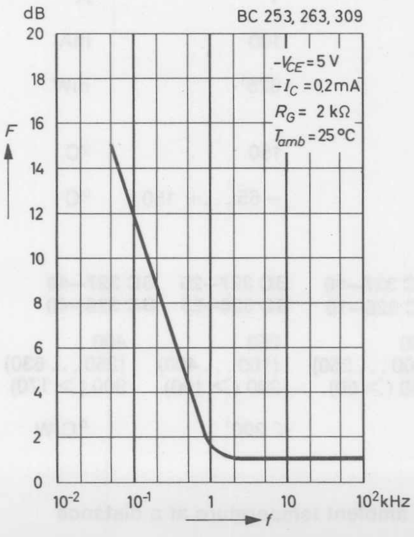
**Noise figure versus collector current**



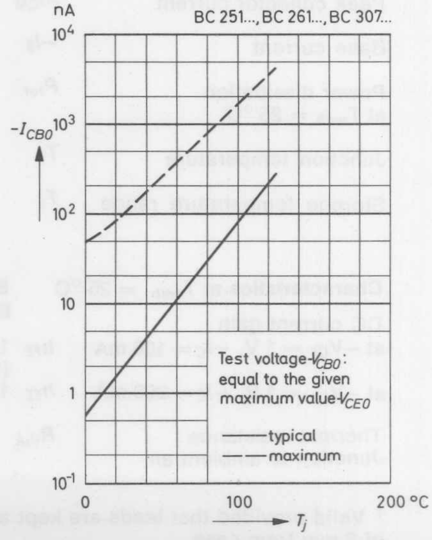

**Noise figure versus collector emitter voltage**




**Noise figure versus frequency**



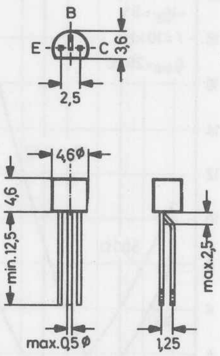

**Collector cutoff current versus ambient temperature**



# BC 327, BC 328

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications. Especially suitable for AF-driver stages and low power output stages.

These types are subdivided into three groups –16, –25 and –40, according to their DC current gain. As complementary types the NPN transistors BC 337 and BC 338 are recommended.




Plastic package ≈ JEDEC TO-92, TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

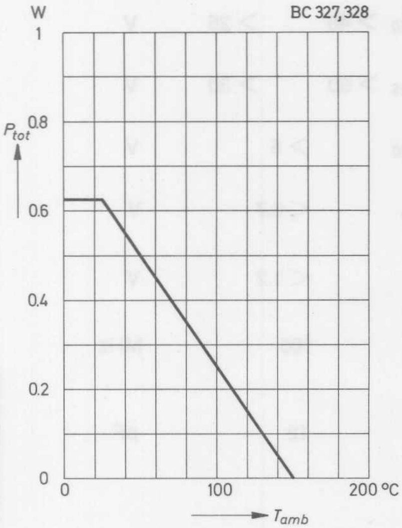
| Maximum Ratings | | BC 327 | BC 328 | |
|---|---|---|---|---|
| Collector emitter voltage | $-V_{CES}$ | 50 | 30 | V |
| Collector emitter voltage | $-V_{CEO}$ | 45 | 25 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | | V |
| Collector current | $-I_C$ | 800 | | mA |
| Peak collector current | $-I_{CM}$ | 1 | | A |
| Base current | $-I_B$ | 100 | | mA |
| Power dissipation at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | 625[1] | | mW |
| Junction temperature | $T_j$ | 150 | | °C |
| Storage temperature range | $T_S$ | – 55 . . . + 150 | | °C |

| Characteristics at $T_{amb} = 25\ ^\circ C$ | | BC 327–16<br>BC 328–16 | BC 327–25<br>BC 328–25 | BC 327–40<br>BC 328–40 | |
|---|---|---|---|---|---|
| DC current gain at $-V_{CE} = 1$ V, $-I_C = 100$ mA | $h_{FE}$ | 160<br>(100 . . . 250) | 250<br>(160 . . . 400) | 400<br>(250 . . . 630) | |
| at $-V_{CE} = 1$ V, $-I_C = 300$ mA | $h_{FE}$ | 130 (> 60) | 200 (> 100) | 300 (> 170) | |
| Thermal resistance Junction to ambient air | $R_{thA}$ | | < 200[1] | | °C/W |

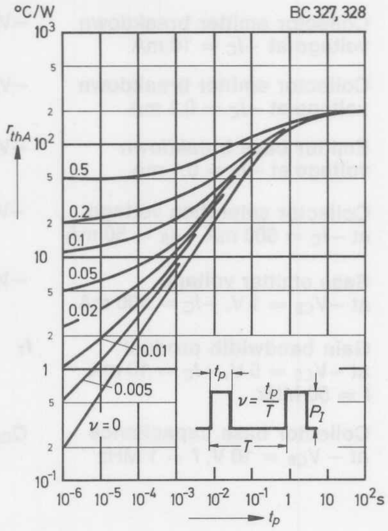
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | BC 327 | BC 328 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $-V_{CE} = 25$ V | $-I_{CES}$ | – | 2 (< 100) | nA |
| at $-V_{CE} = 45$ V | $-I_{CES}$ | 2 (< 100) | – | nA |
| at $-V_{CE} = 25$ V, $T_{amb} = 125$ °C | $-I_{CES}$ | – | < 10 | µA |
| at $-V_{CE} = 45$ V, $T_{amb} = 125$ °C | $-I_{CES}$ | < 10 | – | µA |
| Collector emitter breakdown voltage at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | > 45 | > 25 | V |
| Collector emitter breakdown voltage at $-I_C = 0.1$ mA | $-V_{(BR)CES}$ | > 50 | > 30 | V |
| Emitter base breakdown voltage at $-I_E = 0.1$ mA | $-V_{(BR)EBO}$ | > 5 | | V |
| Collector saturation voltage at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | < 0.7 | | V |
| Base emitter voltage at $-V_{CE} = 1$ V, $-I_C = 300$ mA | $-V_{BE}$ | < 1.2 | | V |
| Gain bandwidth product at $-V_{CE} = 5$ V, $-I_C = 10$ mA, $f = 50$ MHz | $f_T$ | 100 | | MHz |
| Collector base capacitance at $-V_{CB} = 10$ V, $f = 1$ MHz | $C_{CB0}$ | 12 | | pF |

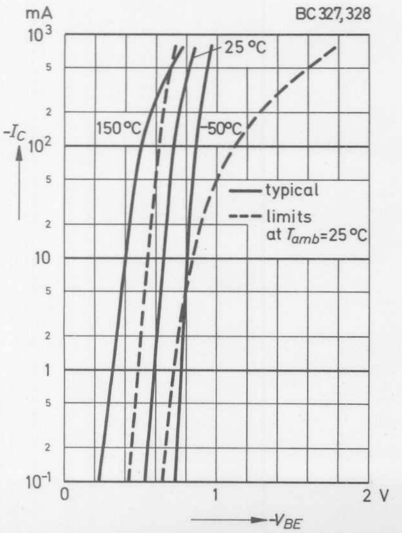
**Admissible power dissipation versus ambient temperature**
(see note on page 250)



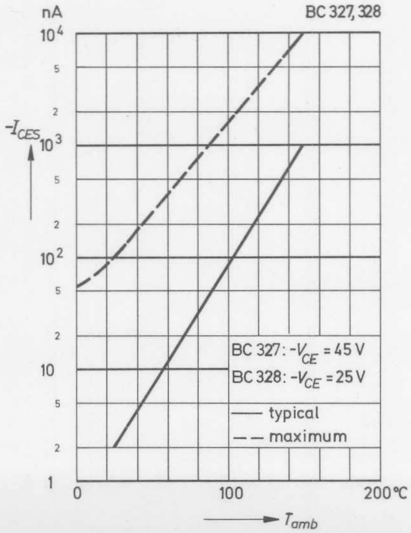

**Pulse thermal resistance versus pulse duration**
(see note on page 250)



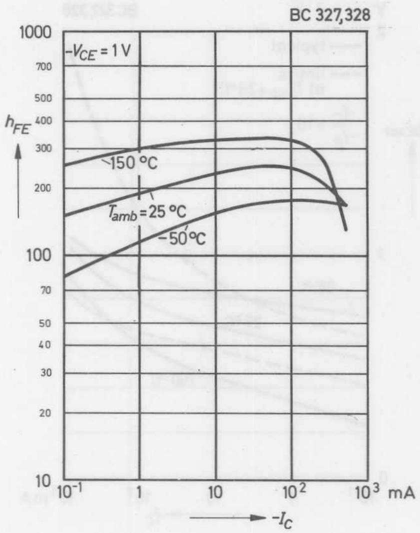

**Collector current versus base emitter voltage**



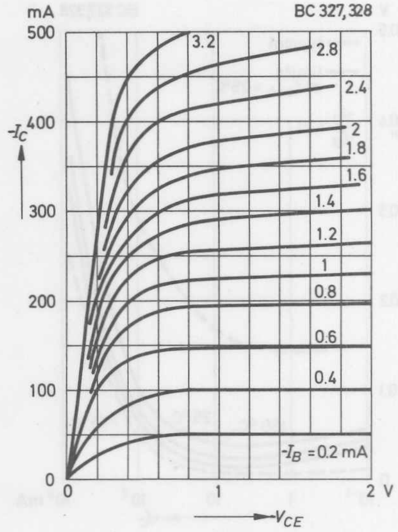

**Collector cutoff current versus ambient temperature**



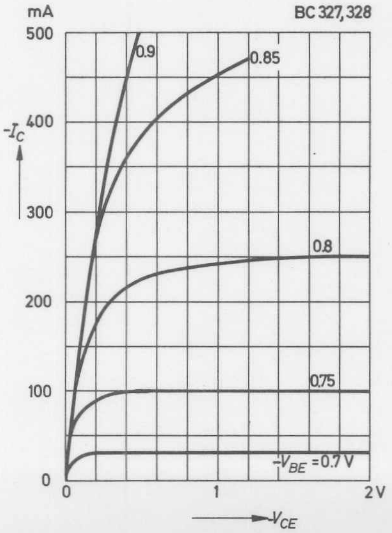
**DC current gain versus collector current**



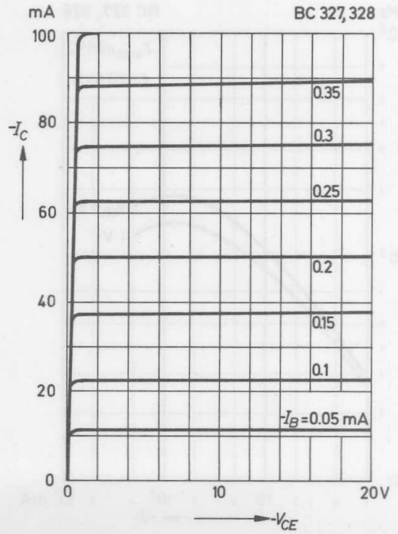

**Common emitter collector characteristics**



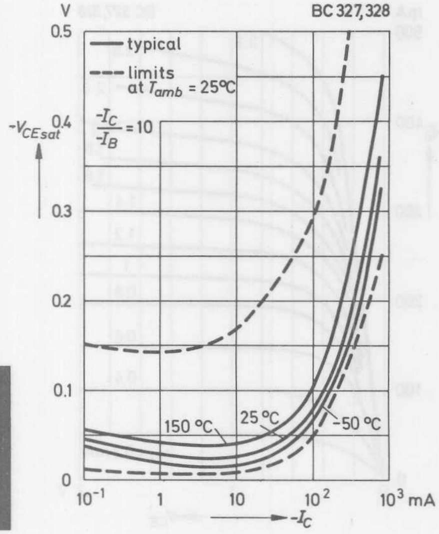

**Common emitter collector characteristics**



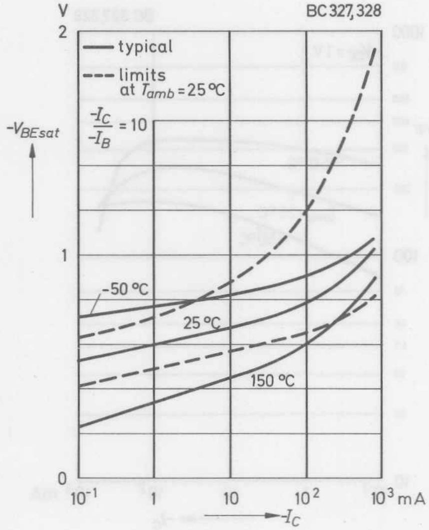

**Common emitter collector characteristics**



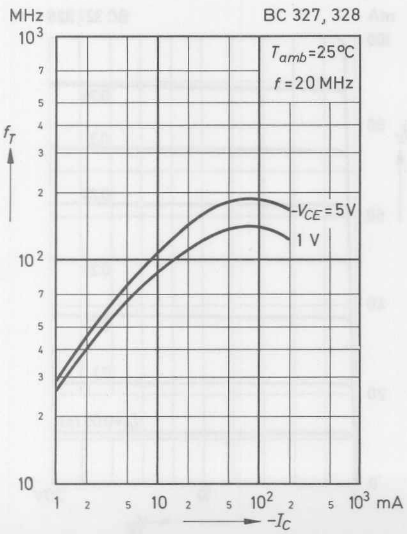
**Collector saturation voltage versus collector current**




**Base saturation voltage versus collector current**



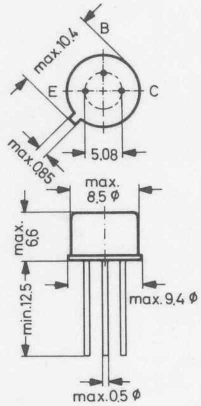

**Gain bandwidth product versus collector current**



# BC 360, BC 361

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications

The type BC 360 is subdivided into three groups, –6, –10 and –16, the type BC 361 into two groups, –6 and –10, according to the DC current gain. As complementary types the NPN transistors BC 340 and BC 341 are recommended.



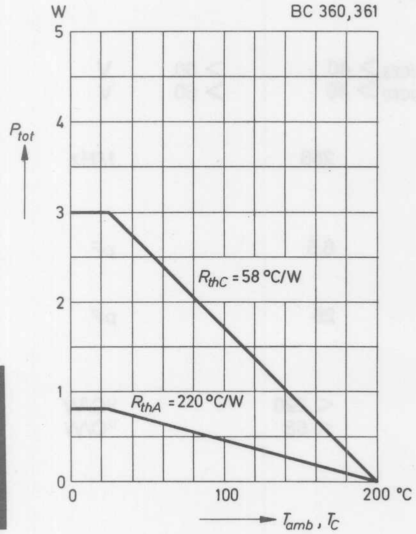

Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

| **Maximum Ratings** | | **BC 360** | **BC 361** | |
|---|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 40 | 60 | V |
| Collector emitter voltage | $-V_{CE0}$ | 40 | 60 | V |
| Emitter base voltage | $-V_{EB0}$ | 5 | 5 | V |
| Collector current | $-I_C$ | 500 | | mA |
| Base current | $-I_B$ | 50 | | mA |
| Power dissipation | | | | |
| at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | 0.8 | | W |
| at $T_C = 25\ ^\circ C$ | $P_{tot}$ | 3 | | W |
| Junction temperature | $T_j$ | 200 | | °C |
| Storage temperature range | $T_S$ | –55 . . . +200 | | °C |

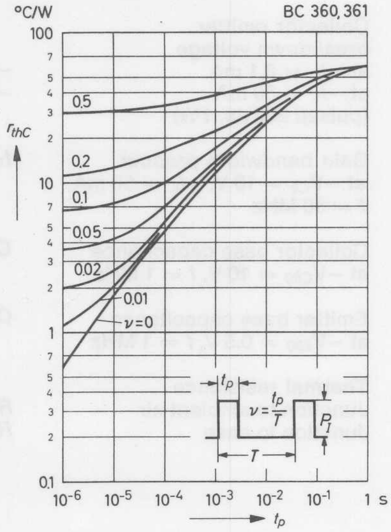
| **Characteristics** at $T_j = 25\ ^\circ C$ | | **BC 360-6** **BC 361-6** | **BC 360-10** **BC 361-10** | **BC 360-16** | |
|---|---|---|---|---|---|
| DC current gain | | | | | |
| at $-V_{CE} = 5$ V, $-I_C = 0.1$ mA | $h_{FE}$ | 40 | 65 | 100 | |
| at $-V_{CE} = 5$ V, $-I_C = 50$ mA | $h_{FE}$ | 63 (40...100) | 100 (63...160) | 160 (100...250) | |
| at $-V_{CE} = 5$ V, $-I_C = 500$ mA | $h_{FE}$ | 20 | 30 | 48 | |
| Collector saturation voltage at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | < 0.4 | | | V |
| Base saturation voltage at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | 0.95 (< 1.2) | | | V |

| | | BC 360 | BC 361 | |
|---|---|---|---|---|
| Collector cutoff current | | | | |
| at $-V_{CE} = 40$ V | $-I_{CES}$ | 10 (< 100) | – | nA |
| at $-V_{CE} = 60$ V | $-I_{CES}$ | – | 10 (< 100) | nA |
| at $-V_{CE} = 40$ V, $T_j = 150$ °C | $-I_{CES}$ | 10 (< 100) | – | µA |
| at $-V_{CE} = 60$ V, $T_j = 150$ °C | $-I_{CES}$ | – | 10 (< 100) | µA |
| Collector emitter breakdown voltage | | | | |
| at $-I_C = 0.1$ mA | $-V_{(BR)CES}$ | > 40 | > 60 | V |
| at $-I_C = 30$ mA (pulsed 200 µs, 1%) | $-V_{(BR)CEO}$ | > 40 | > 60 | V |
| Gain bandwidth product at $-V_{CE} = 10$ V, $-I_C = 50$ mA, $f = 50$ MHz | $f_T$ | 250 | | MHz |
| Collector base capacitance at $-V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | 6.5 | | pF |
| Emitter base capacitance at $-V_{EBO} = 0.5$ V, $f = 1$ MHz | $C_{EBO}$ | 25 | | pF |
| Thermal resistance | | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | | °C/W |
| Junction to case | $R_{thC}$ | < 58 | | °C/W |

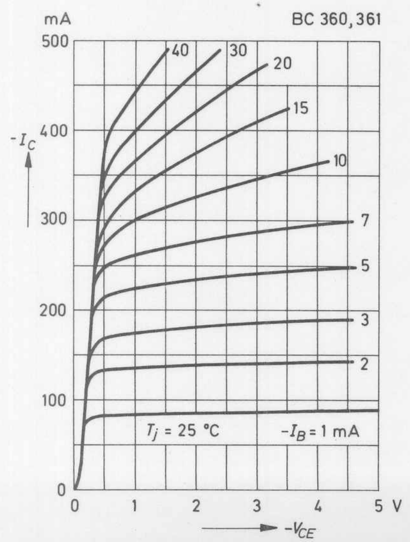
### Admissible power dissipation versus temperature



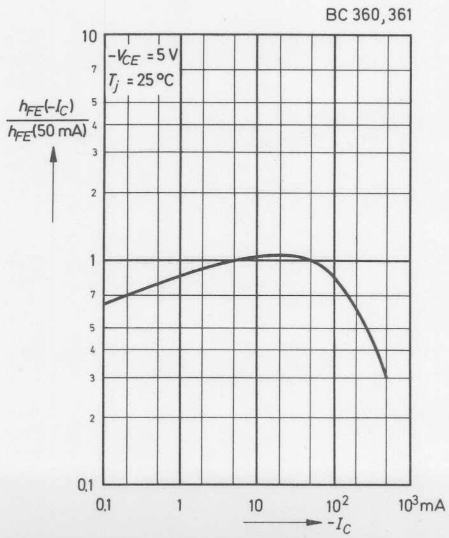

### Pulse thermal resistance versus pulse duration



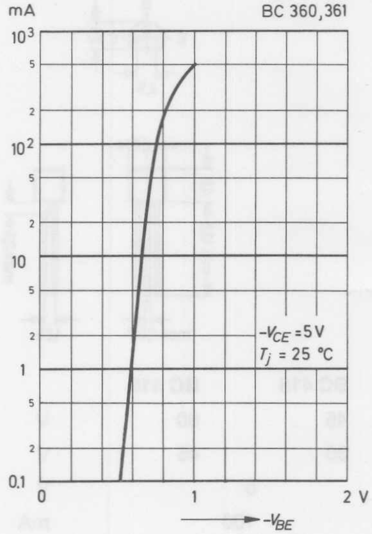

### Common emitter collector characteristics



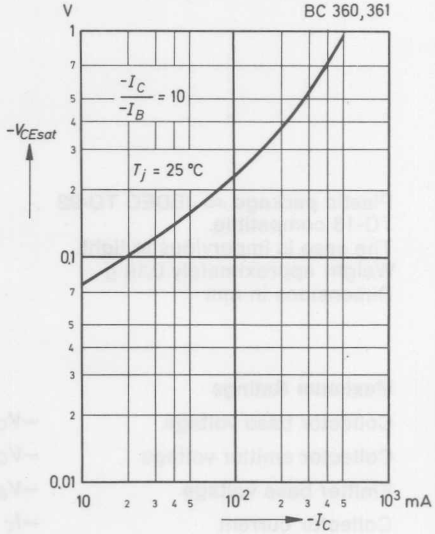

### Relative DC current gain versus collector current



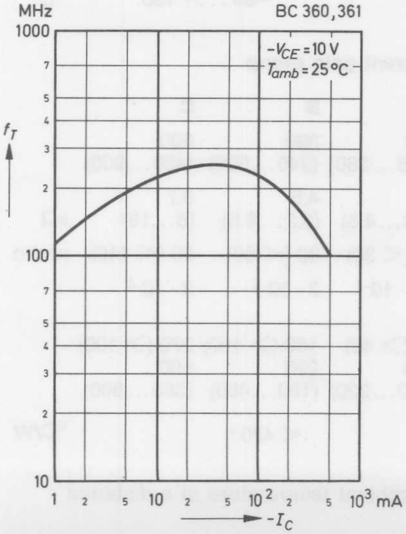
**Collector current versus base emitter voltage**



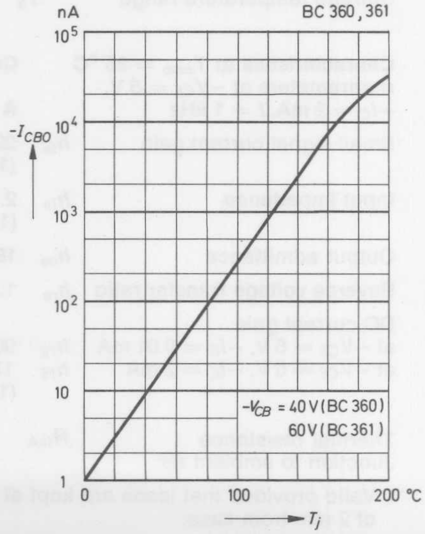

**Collector saturation voltage versus collector current**




**Gain bandwidth product versus collector current**

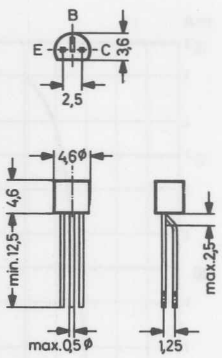



**Collector cutoff current versus junction temperature**



**PNP Silicon Epitaxial Planar Transistors**
for use in high-quality, low-noise AF and DC amplifiers. Complementary types are the NPN transistors BC 413 and BC 414.

These types are subdivided into three groups -6, -10 and -16, according to their DC current gain.



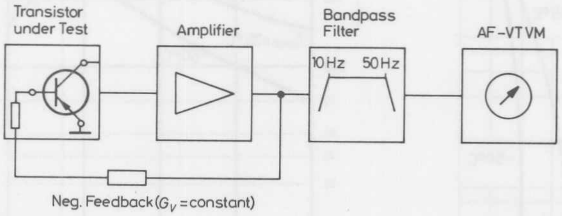

Plastic package ≈ JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

| **Maximum Ratings** | | **BC 415** | **BC 416** | |
|---|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 45 | 50 | V |
| Collector emitter voltage | $-V_{CEO}$ | 30 | 45 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | | V |
| Collector current | $-I_C$ | 100 | | mA |
| Base current | $-I_B$ | 20 | | mA |
| Power dissipation at $T_{amb} = 25\,°C$ | $P_{tot}$ | 300[1] | | mW |
| Junction temperature | $T_j$ | 150 | | °C |
| Storage temperature range | $T_S$ | −65 ... +150 | | °C |

| **Characteristics** at $T_{amb} = 25\,°C$ | | **Current gain group** | | | |
|---|---|---|---|---|---|
| $h$-parameters at $-V_{CE} = 5$ V, $-I_C = 2$ mA, $f = 1$ kHz | | **A** | **B** | **C** | |
| Small signal current gain | $h_{fe}$ | 222 (125...260) | 330 (240...500) | 600 (450...900) | |
| Input impedance | $h_{ie}$ | 2.7 (1.6...4.5) | 4.5 (3.2...8.5) | 8.7 (6...15) | kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 30 (< 60) | 60 (< 110) | µmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |
| DC current gain at $-V_{CE} = 5$ V, $-I_C = 0.01$ mA | $h_{FE}$ | 90 (> 40) | 150 (> 100) | 270 (> 100) | |
| at $-V_{CE} = 5$ V, $-I_C = 2$ mA | $h_{FE}$ | 170 (120...220) | 290 (180...460) | 500 (380...800) | |
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 420[1] | | | °C/W |

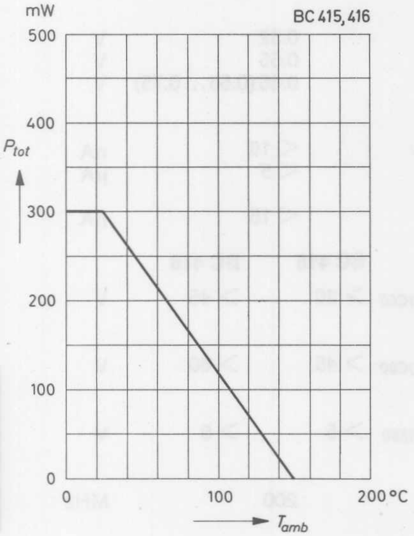
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | | |
|---|---|---|---|---|
| Collector saturation voltage | | | | |
| at $-I_C =$ 10 mA, $-I_B = 0.5$ mA | $-V_{CE\,sat}$ | 0.075 (< 0.25) | | V |
| at $-I_C = 100$ mA, $-I_B = 5$ mA | $-V_{CE\,sat}$ | 0.25 (< 0.6) | | V |
| Base saturation voltage at $-I_C = 100$ mA, $-I_B = 5$ mA | $-V_{BE\,sat}$ | 0.9 | | V |
| Base emitter voltage | | | | |
| at $-V_{CE} = 5$ V, $-I_C = 0.01$ mA | $-V_{BE}$ | 0.52 | | V |
| at $-V_{CE} = 5$ V, $-I_C = 0.1$ mA | $-V_{BE}$ | 0.55 | | V |
| at $-V_{CE} = 5$ V, $-I_C = 2$ mA | $-V_{BE}$ | 0.65 (0.55…0.75) | | V |
| Collector cutoff current | | | | |
| at $-V_{CB} = 30$ V | $-I_{CBO}$ | < 15 | | nA |
| at $-V_{CB} = 30$ V, $T_{amb} = 150$ °C | $-I_{CBO}$ | < 5 | | µA |
| Emitter cutoff current at $-V_{EB} = 4$ V | $-I_{EBO}$ | < 15 | | nA |
| | | **BC 415** | **BC 416** | |
| Collector emitter breakdown voltage at $-I_{CE} = 10$ mA | $-V_{(BR)CEO}$ | > 30 | > 45 | V |
| Collector base breakdown voltage at $-I_{CB} = 10$ µA | $-V_{(BR)CBO}$ | > 45 | > 50 | V |
| Emitter base breakdown voltage at $-I_{EB} = 10$ µA | $-V_{(BR)EBO}$ | > 5 | > 5 | V |
| Gain bandwidth product at $-V_{CE} = 5$ V, $-I_C = 10$ mA, $f = 100$ MHz | $f_T$ | 200 | | MHz |
| Collector base capacitance at $-V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | 4.5 | | pF |
| Noise figure at $-V_{CE} = 5$ V, $-I_C = 0.2$ mA, $R_G = 2$ kΩ, $f = 30$ Hz . . . 15 kHz | $F$ | < 2 | | dB |
| Equivalent noise EMF (referred to base) at $-V_{CE} = 5$ V, $-I_C = 0.2$ mA, $R_G = 2$ kΩ, $f = 10 . . . 50$ Hz | $v_r$ | < 0.11 | | µV |

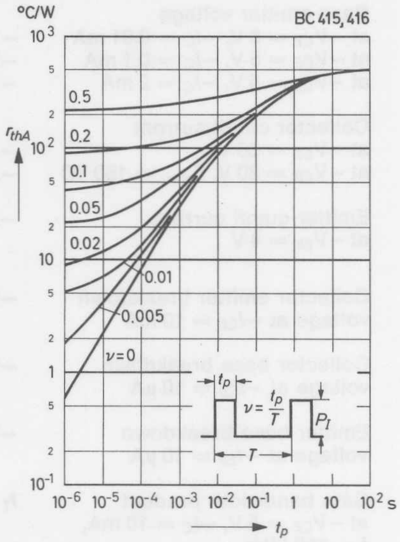



**Test circuit for equivalent noise EMF**

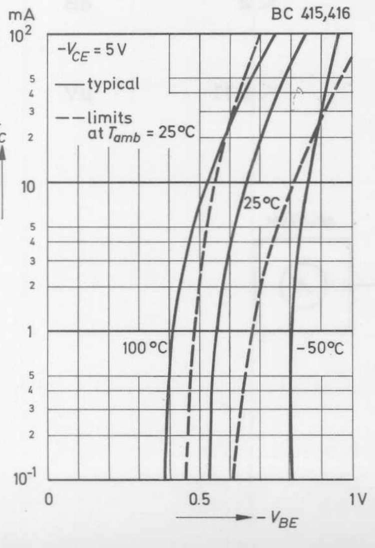
**Admissible power dissipation versus ambient temperature**
(see note on page 260)



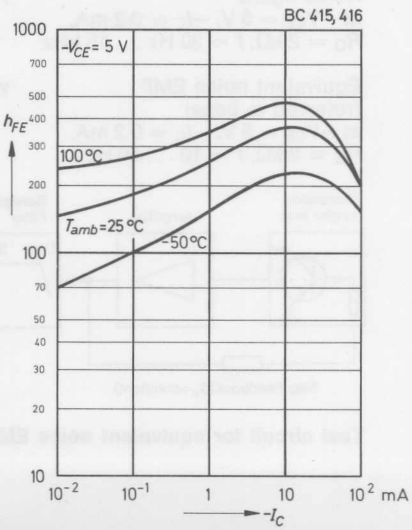

**Pulse thermal resistance versus pulse duration**
(see note on page 260)



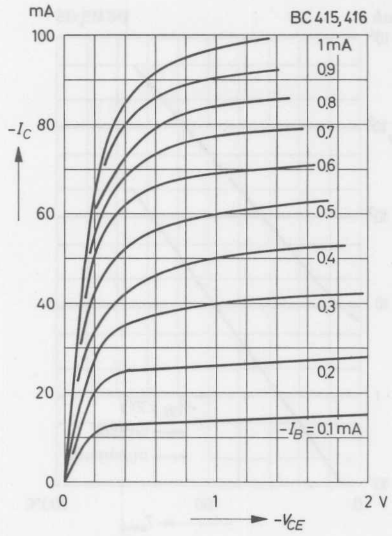

**Collector current versus base emitter voltage**



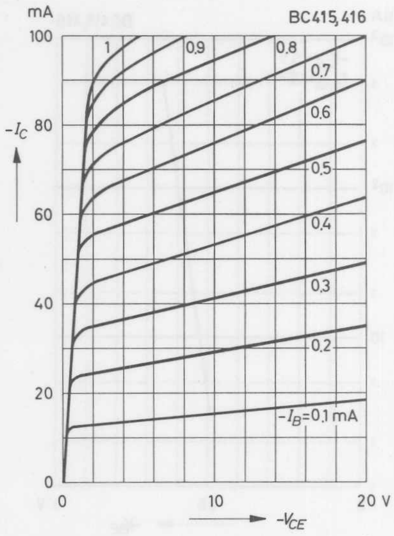

**DC current gain versus collector current**



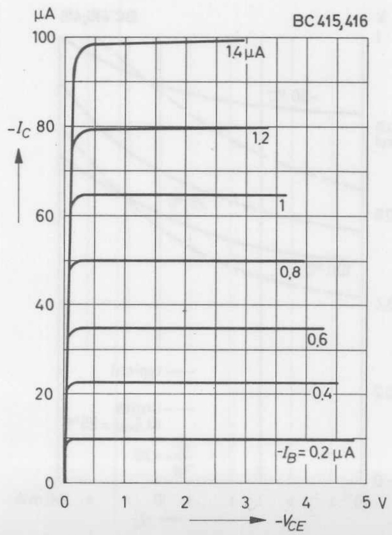
**Common emitter collector characteristics**



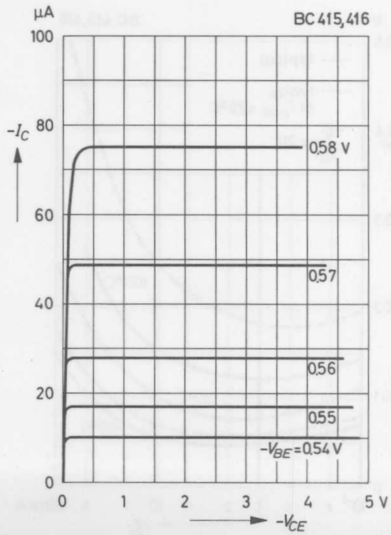

**Common emitter collector characteristics**



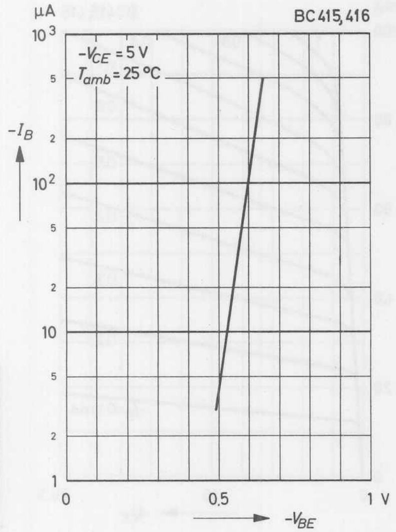

**Common emitter collector characteristics**



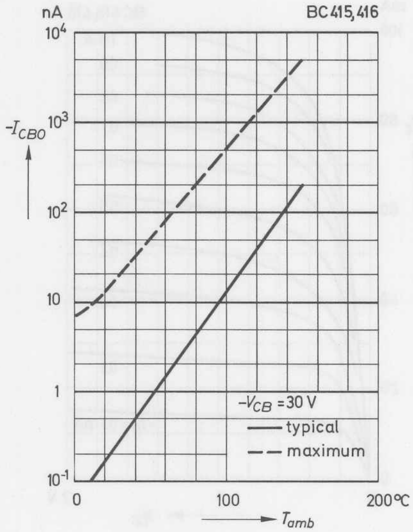

**Common emitter collector characteristics**



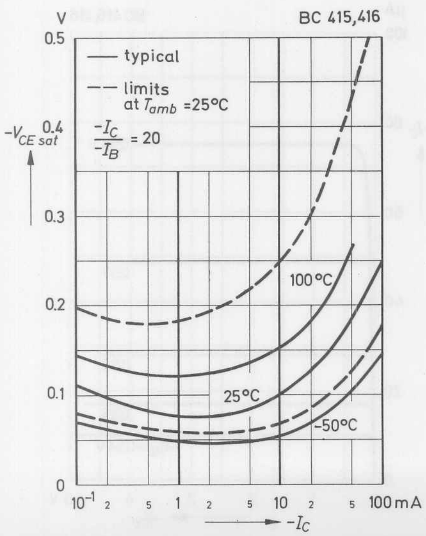
**Common emitter input characteristic**



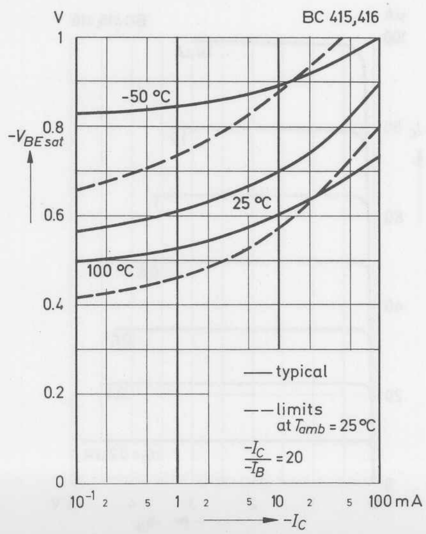

**Collector cutoff current versus ambient temperature**



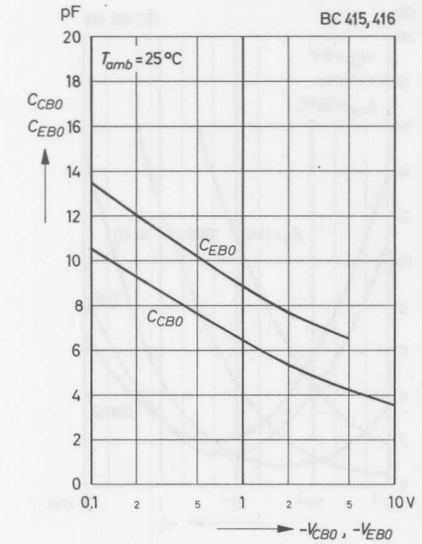

**Collector saturation voltage versus collector current**



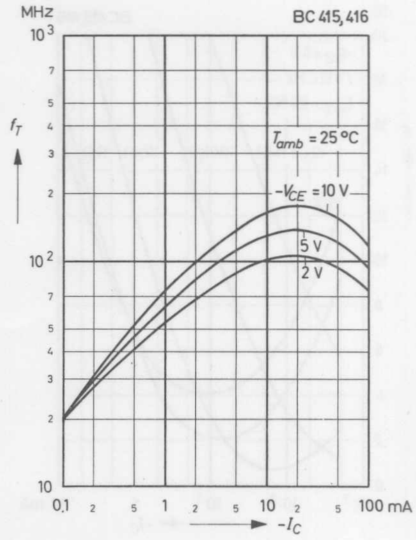

**Base saturation voltage versus collector current**



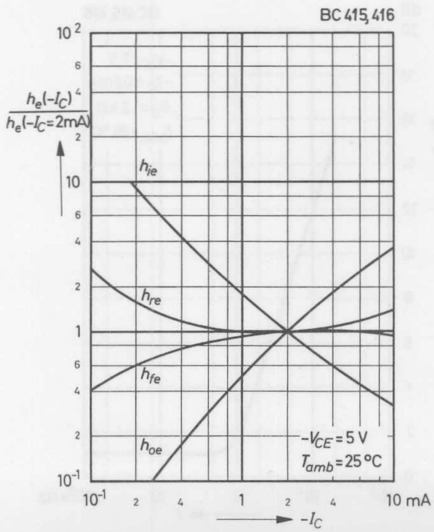
**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



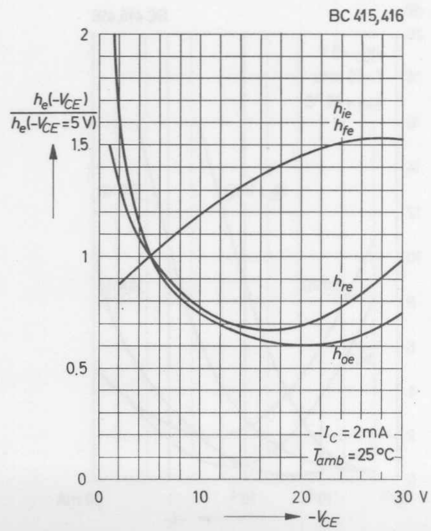

**Gain bandwidth product versus collector current**



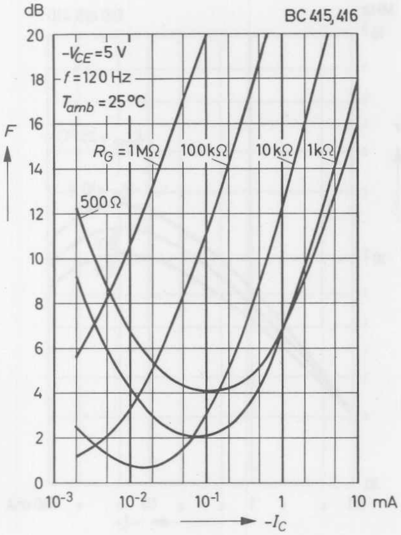

**Relative *h*-parameters versus collector current**



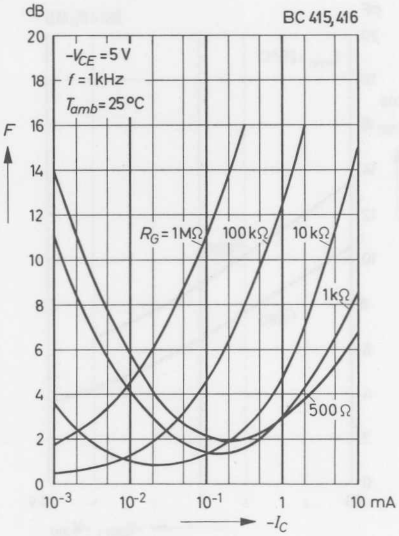

**Relative *h*-parameters versus collector emitter voltage**



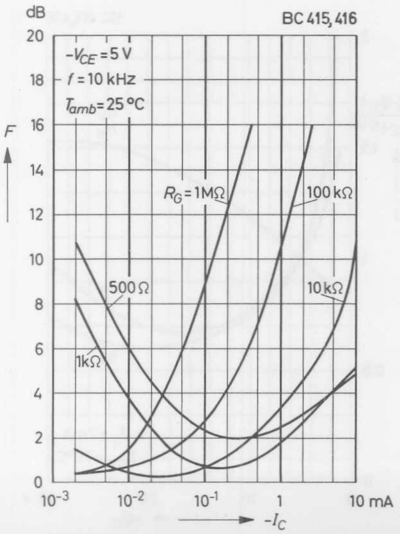
**Noise figure
versus collector current**



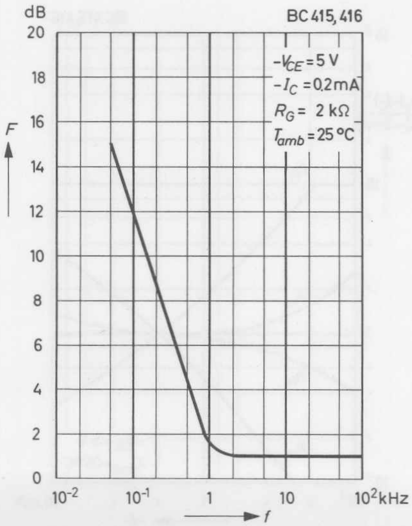

**Noise figure
versus collector current**



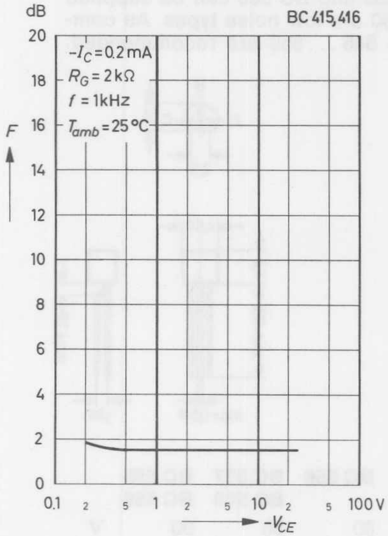

**Noise figure
versus collector current**




**Noise figure
versus frequency**



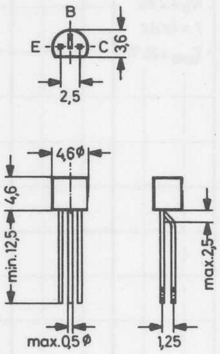
**Noise figure**
**versus collector emitter voltage**



# BC 556 . . . BC 560

**PNP Silicon Epitaxial Planar Transistors**
for switching and AF amplifier applications.

These transistors are subdivided into three groups A, B and C according to their current gain. The types BC 556 and BC 557 are available in groups A and B, however, the types BC 558, BC 559 and BC 560 can be supplied in all three groups. The BC 559 and BC 560 are low noise types. As complementary types the NPN transistors BC 546 . . . 550 are recommended.




Plastic package ≈ JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

| **Maximum Ratings** | | **BC 556** | **BC 557**<br>**BC 560** | **BC 558**<br>**BC 559** | |
|---|---|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 80 | 50 | 30 | V |
| Collector emitter voltage | $-V_{CES}$ | 80 | 50 | 30 | V |
| Collector emitter voltage | $-V_{CEO}$ | 65 | 45 | 30 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | 5 | 5 | V |
| Collector current | $-I_C$ | 100 | 100 | 100 | mA |
| Peak collector current | $-I_{CM}$ | 200 | 200 | 200 | mA |
| Peak base current | $-I_{BM}$ | 200 | 200 | 200 | mA |
| Peak emitter current | $-I_{EM}$ | 200 | 200 | 200 | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | | 500 [1]) | | mW |
| Junction temperature | $T_j$ | | 150 | | °C |
| Storage temperature range | $T_S$ | | – 65 . . . +150 | | °C |

[1]) Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

**Characteristics** at $T_{amb} = 25\ °C$

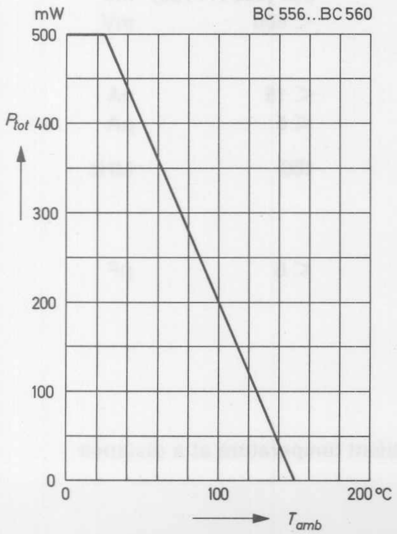
| $h$-Parameters at $-V_{CE} = 5$ V, $-I_C = 2$ mA, $f = 1$ kHz | | Current Gain Group A | B | C | |
|---|---|---|---|---|---|
| Current gain | $h_{fe}$ | 220 (125...260) | 330 (240...500) | 600 (450...900) | |
| Input impedance | $h_{ie}$ | 2.7 (1.6...4.5) | 4.5 (3.2...8.5) | 8.7 (6...15) | kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 30 (< 60) | 60 (< 110) | µmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |
| DC current gain | | | | | |
| at $-V_{CE} = 5$ V, $I_C = 10$ µA | $h_{FE}$ | 90 | 150 | 270 | |
| at $-V_{CE} = 5$ V, $I_C = 2$ mA | $h_{FE}$ | 180 | 290 | 500 | |
| at $-V_{CE} = 5$ V, $I_C = 100$ mA | $h_{FE}$ | 120 | 200 | 400 | |

| | | | |
|---|---|---|---|
| Thermal resistance Junction to ambient air | $R_{thA}$ | < 250 [1] | °C/W |
| Collector saturation voltage | | | |
| at $-I_C = 10$ mA, $-I_B = 0.5$ mA | $-V_{CE\,sat}$ | 90 (< 300) | mV |
| at $-I_C = 100$ mA, $-I_B = 5$ mA | $-V_{CE\,sat}$ | 250 (< 650) | mV |
| Base saturation voltage | | | |
| at $-I_C = 10$ mA, $-I_B = 0.5$ mA | $-V_{BE\,sat}$ | 700 | mV |
| at $-I_C = 100$ mA, $-I_B = 5$ mA | $-V_{BE\,sat}$ | 900 | mV |
| Base emitter voltage | | | |
| at $-V_{CE} = 5$ V, $-I_C = 2$ mA | $-V_{BE}$ | 660 (600 . . . 750) | mV |
| at $-V_{CE} = 5$ V, $-I_C = 10$ mA | $-V_{BE}$ | < 800 | mV |
| Collector cutoff current | | | |
| at $-V_{CB} = 30$ V | $-I_{CB0}$ | < 15 | nA |
| at $-V_{CB} = 30$ V, $T_j = 150$ °C | $-I_{CB0}$ | < 5 | µA |
| Gain bandwidth product at $-V_{CE} = 5$ V, $-I_C = 10$ mA, $f = 100$ MHz | $f_T$ | 150 | MHz |
| Collector base capacitance at $-V_{CB} = 10$ V, $f = 1$ MHz | $C_{CB0}$ | < 6 | pF |

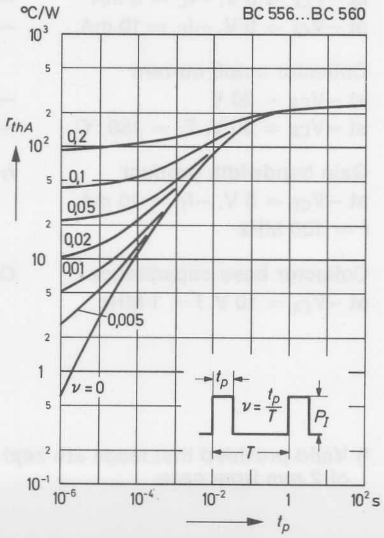
[1]) Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | BC 556<br>BC 557<br>BC 558 | BC 559<br>BC 560 | |
|---|---|---|---|---|
| Noise figure<br>at $-V_{CE} = 5$ V, $-I_C = 200$ µA,<br>$R_G = 2$ kΩ, $f = 1$ kHz, $\Delta f = 200$ Hz | $F$ | 2 (< 10) | 1 (< 4) | dB |
| | | BC 559 | BC 560 | |
| Noise figure<br>at $-V_{CE} = 5$ V, $-I_C = 200$ µA,<br>$R_G = 2$ kΩ, $f = 30 \ldots 15\,000$ Hz | $F$ | 1.2 (< 4) | 1.2 (< 2) | dB |
| Equivalent noise EMF<br>at $-V_{CE} = 5$ V, $-I_C = 200$ µA,<br>$R_G = 2$ kΩ, $f = 10 \ldots 50$ Hz | $v_r$ | < 0.11 | < 0.11 | µV |

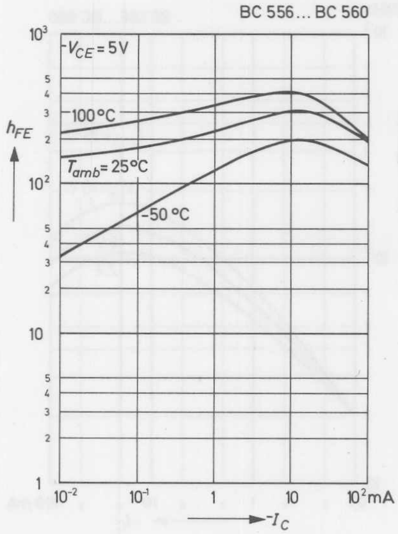
**Admissible power dissipation versus temperature**
(see note on page 269)



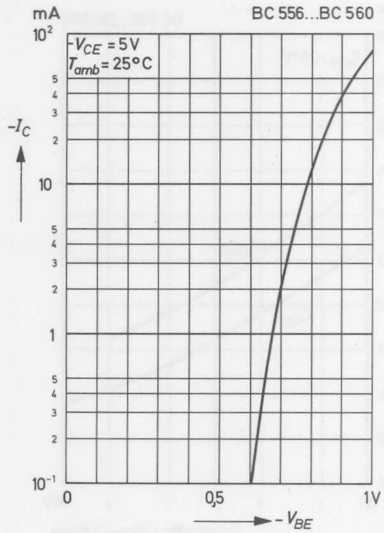

**Pulse thermal resistance versus pulse duration**
(see note on page 269)



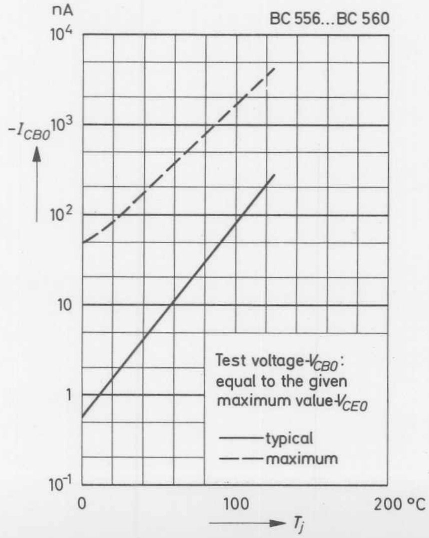
**DC gurrent gain versus collector current**



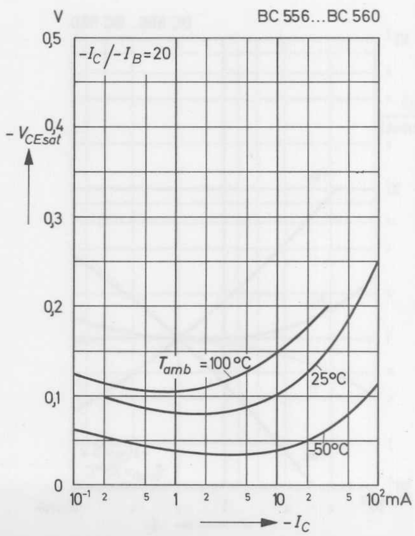

**Collector current versus base emitter voltage**



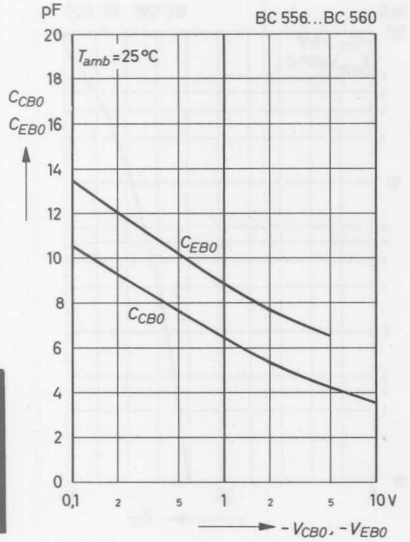

**Collector cutoff current versus junction temperature**



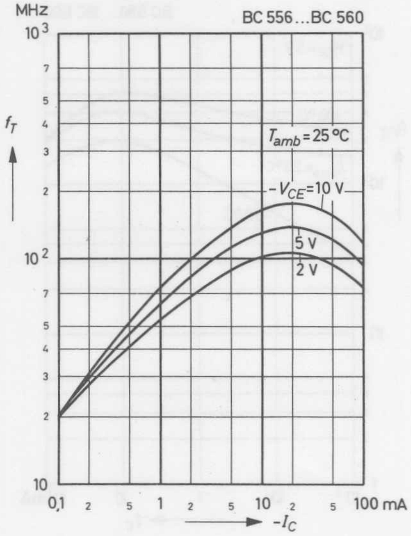

**Collector saturation voltage versus collector current**



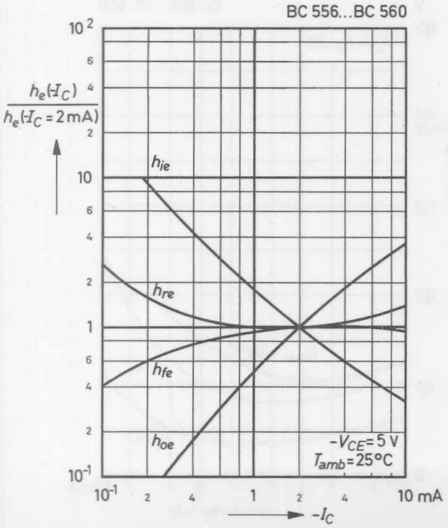
**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



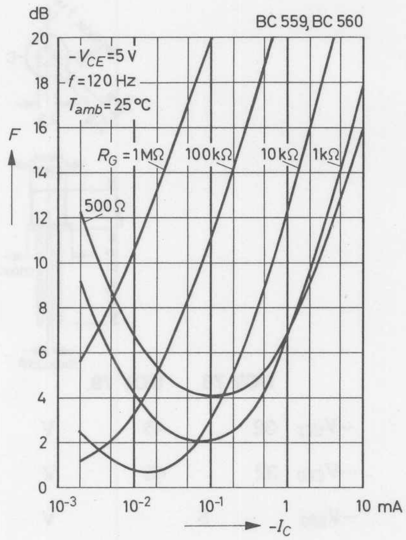

**Gain bandwidth product versus collector current**



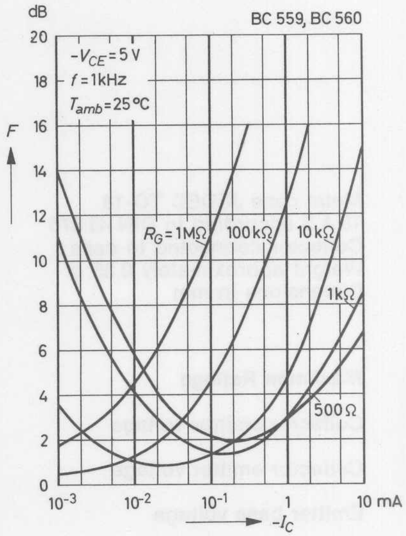

**Relative *h*-parameters versus collector current**



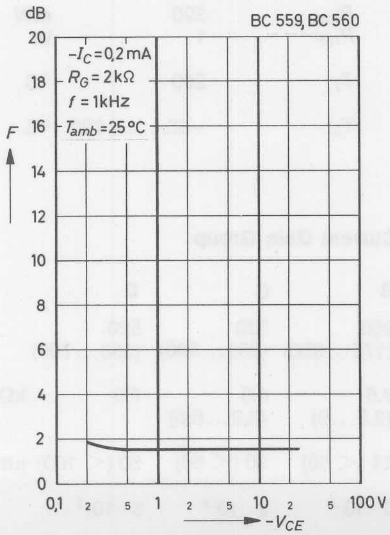
**Noise figure versus collector curent**




**Noise figure versus collector current**



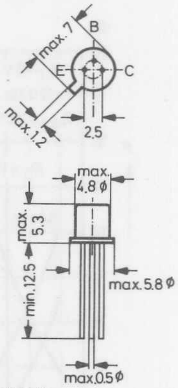

**Noise figure versus collector emitter voltage**



# BCY 78, BCY 79

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications in commercial electronic design

These Transistors are subdivided into four groups A, B, C and D according to their current gain. Type BCY 79 is available in groups A, B and C only.




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

| **Maximum Ratings** | | **BCY 78** | **BCY 79** | |
|---|---|---|---|---|
| Collector emitter voltage | $-V_{CES}$ | 32 | 45 | V |
| Collector emitter voltage | $-V_{CEO}$ | 32 | 45 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | | V |
| Collector current | $-I_C$ | 200 | | mA |
| Base current | $-I_B$ | 50 | | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 390 | | mW |
| at $T_C = 45\ °C$ | $P_{tot}$ | 1 | | W |
| Junction temperature | $T_j$ | 200 | | °C |
| Storage temperature range | $T_S$ | −65. . . .+200 | | °C |

**Characteristics** at $T_{amb} = 25\ °C$

| $h$-parameters at $-V_{CE} = 5$ V, $-I_C = 2$ mA, $f = 1$ kHz | | **Current Gain Group** A | B | C | D | |
|---|---|---|---|---|---|---|
| Small signal current gain | $h_{fe}$ | 200 (125...250) | 260 (175...350) | 330 (250...500) | 520 (350...700) | |
| Input impedance | $h_{ie}$ | 2.7 (1.6...4.5) | 3.6 (2.5...6) | 4.5 (3.2...8.5) | 7.5 | kΩ |
| Output admittance | $h_{oe}$ | 18 (< 30) | 24 (< 50) | 30 (< 60) | 50 (< 100) | µmho |
| Reverse voltage transfer ratio | $h_{re}$ | $1.5 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $2 \cdot 10^{-4}$ | $3 \cdot 10^{-4}$ | |

| | | Current Gain Group | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| DC current gain at $-V_{CE} = 5$ V, $-I_C = 10\ \mu A$ | $h_{FE}$ | 140 | 200 (> 30) | 270 (> 40) | 340 (> 100) |
| at $-V_{CE} = 5$ V, $-I_C = 2$ mA | $h_{FE}$ | 170 (120…220) | 250 (180…310) | 350 (250…460) | 500 (380…630) |
| at $-V_{CE} = 1$ V, $-I_C = 10$ mA | $h_{FE}$ | 180 (> 80) | 260 (120…400) | 360 (160…630) | 500 (240…1000) |
| at $-V_{CE} = 1$ V, $-I_C = 100$ mA | $h_{FE}$ | > 40 | > 45 | > 60 | > 60 |

| | | | |
|---|---|---|---|
| **Base emitter voltage** | | | |
| at $-V_{CE} = 5$ V, $-I_C = 10\ \mu A$ | $-V_{BE}$ | 0.55 | V |
| at $-V_{CE} = 5$ V, $-I_C = 2$ mA | $-V_{BE}$ | 0.65 (0.6…0.75) | V |
| at $-V_{CE} = 1$ V, $-I_C = 10$ mA | $-V_{BE}$ | 0.68 | V |
| at $-V_{CE} = 1$ V, $-I_C = 100$ mA | $-V_{BE}$ | 0.75 | V |
| **Collector saturation voltage** | | | |
| at $-I_C = 10$ mA, $-I_B = 0.25$ mA | $-V_{CE\,sat}$ | 0.12 (0.06…0.25) | V |
| at $-I_C = 100$ mA, $-I_B = 2.5$ mA | $-V_{CE\,sat}$ | 0.4 (0.2…0.8) | V |
| **Base saturation voltage** | | | |
| at $-I_C = 10$ mA, $-I_B = 0.25$ mA | $-V_{BE\,sat}$ | 0.7 (0.6…0.85) | V |
| at $-I_C = 100$ mA, $-I_B = 2.5$ mA | $-V_{BE\,sat}$ | 0.85 (0.7…1.2) | V |

| | | BCY 78 | BCY 79 | |
|---|---|---|---|---|
| **Collector cutoff current** | | | | |
| at $-V_{CES} = 25$ V | $-I_{CES}$ | 2 (< 20) | – | nA |
| at $-V_{CES} = 35$ V | $-I_{CES}$ | – | 2 (< 20) | nA |
| at $-V_{CES} = 32$ V | $-I_{CES}$ | < 100 | – | nA |
| at $-V_{CES} = 45$ V | $-I_{CES}$ | – | < 100 | nA |
| at $-V_{CES} = 25$ V, $T_{amb} = 150$ °C | $-I_{CES}$ | < 10 | – | µA |
| at $-V_{CES} = 35$ V, $T_{amb} = 150$ °C | $-I_{CES}$ | – | < 10 | µA |
| at $-V_{CE} = 32$ V, $-V_{BE} = 0.2$ V, $T_{amb} = 100$ °C | $-I_{CEV}$ | < 20 | – | µA |
| at $-V_{CE} = 45$ V, $-V_{BE} = 0.2$ V, $T_{amb} = 100$ °C | $-I_{CEV}$ | – | < 20 | µA |
| **Emitter cutoff current** at $-V_{EBO} = 4$ V | $-I_{EBO}$ | < 20 | < 20 | nA |
| **Collector emitter breakdown voltage** | | | | |
| at $-I_C = 10\ \mu A$ | $-V_{(BR)CEO}$ | > 32 | > 45 | V |
| at $-I_C = 10\ \mu A$ | $-V_{(BR)CES}$ | > 32 | > 45 | V |
| **Emitter base breakdown voltage** at $-I_E = 1\ \mu A$ | $-V_{(BR)EBO}$ | > 5 | > 5 | V |

| | | | |
|---|---|---|---|
| Gain bandwidth product<br>at $-V_{CE} = 5$ V, $-I_C = 10$ mA,<br>$f = 100$ MHz | $f_T$ | 180 | MHz |
| Collector base capacitance<br>at $-V_{CBO} = 10$ V, $f = 1$ MHz | $C_{CBO}$ | 4.5 ($<$ 7) | pF |
| Emitter base capacitance<br>at $-V_{EBO} = 0.5$ V, $f = 1$ MHz | $C_{EBO}$ | 11 ($<$ 15) | pF |
| Noise figure<br>at $-V_{CE} = 5$ V, $-I_C = 0.2$ mA,<br>$R_G = 2$ kΩ, $f = 1$ kHz, $\Delta f = 200$ Hz | $F$ | 2 ($<$ 6) | dB |
| Thermal resistance<br>Junction to ambient air | $R_{thA}$ | $<$ 450 | °C/W |
| Junction to case | $R_{thC}$ | $<$ 150 | °C/W |

**Switching Times**

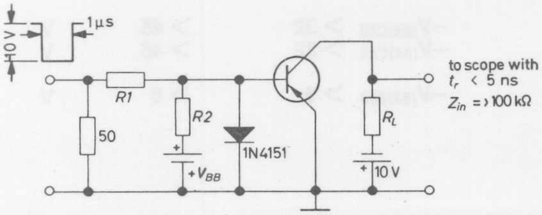
Test conditions:
$-I_C : -I_{B1} : I_{B2} \approx 10 : 1 : 1$ mA,
$R_1 = 5$ kΩ, $R_2 = 5$ kΩ, $R_L = 990$ Ω, $V_{BB} = 3.6$ V

| | | | |
|---|---|---|---|
| Delay time | $t_d$ | 35 | ns |
| Rise time | $t_r$ | 50 | ns |
| Turn-on time | $t_{on}$ | 85 ($<$ 150) | ns |
| Storage time | $t_s$ | 400 | ns |
| Fall time | $t_f$ | 80 | ns |
| Turn-off time | $t_{off}$ | 480 ($<$ 800) | ns |

Test conditions:
$-I_C : -I_{B1} : I_{B2} \approx 100 : 10 : 10$ mA,
$R_1 = 500$ Ω, $R_2 = 700$ Ω, $R_L = 98$ Ω, $V_{BB} = 5$ V

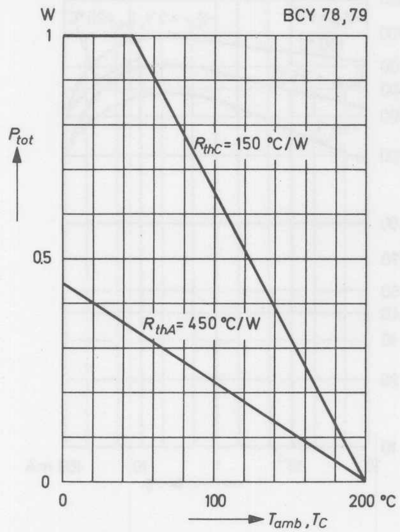
| | | | |
|---|---|---|---|
| Delay time | $t_d$ | 5 | ns |
| Rise time | $t_r$ | 50 | ns |
| Turn-on time | $t_{on}$ | 55 ($<$ 150) | ns |
| Storage time | $t_s$ | 250 | ns |
| Fall time | $t_f$ | 200 | ns |
| Turn-off time | $t_{off}$ | 450 ($<$ 800) | ns |

**Test Circuit for Switching Times**

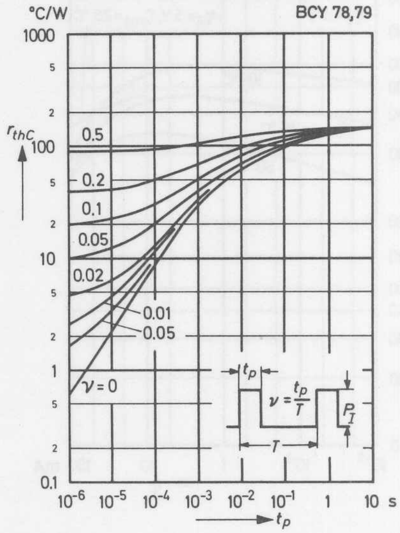



Rise time of input voltage $<$ 5 ns; pulse duty factor $<$ 1 %,
generator impedance 50 Ω

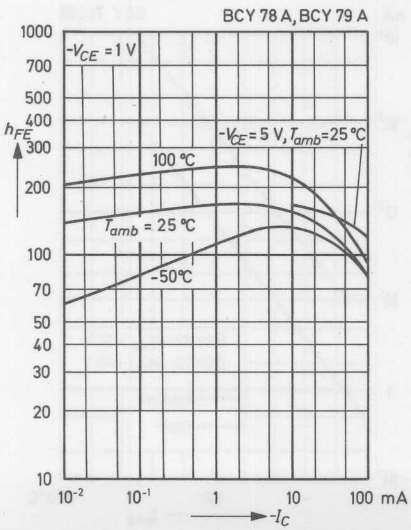
**Admissible power dissipation versus temperature**



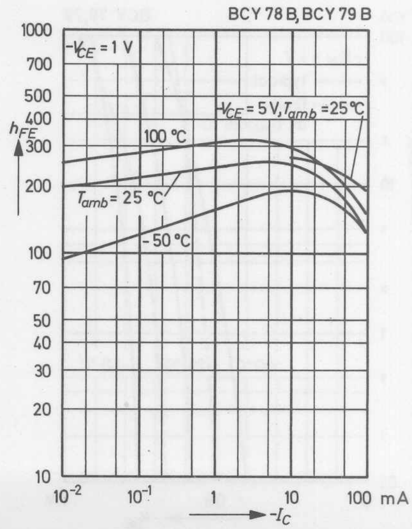

**Pulse thermal resistance versus pulse duration**



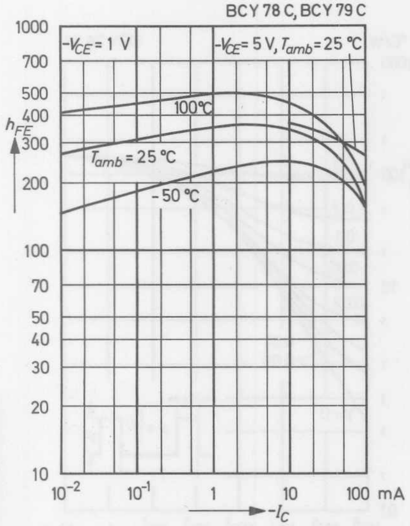

**DC current gain versus collector current**



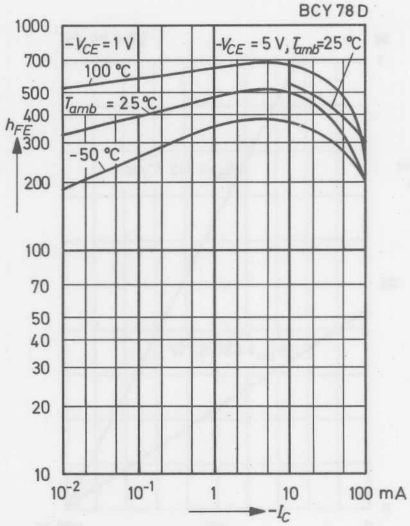

**DC current gain versus collector current**



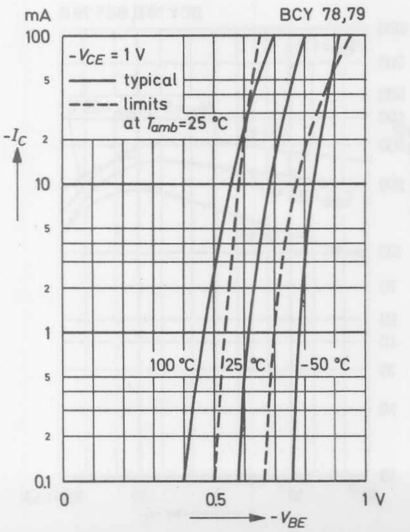
**DC gurrent gain versus collector current**



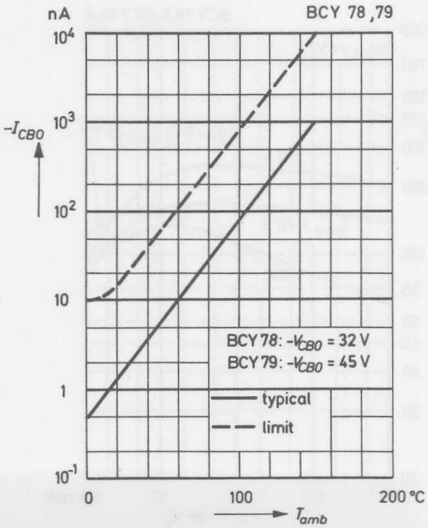

**DC current gain versus collector current**



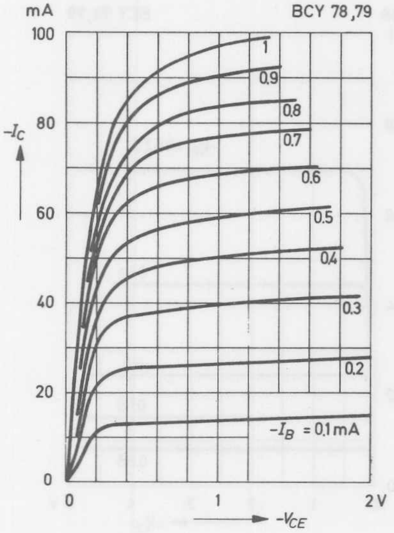

**Collector current versus base emitter voltage**



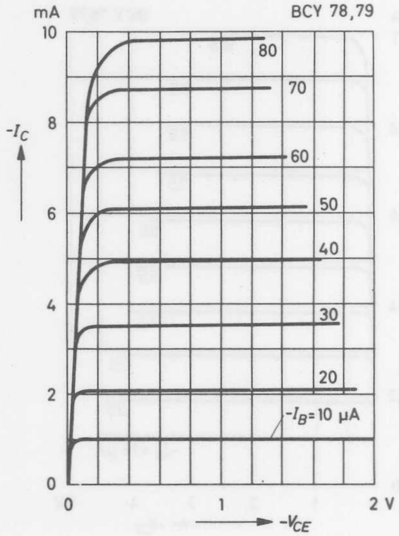

**Collector cutoff current versus ambient temperature**



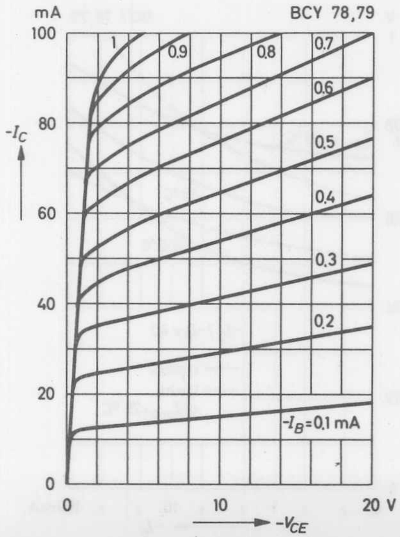
**Common emitter collector characteristics**



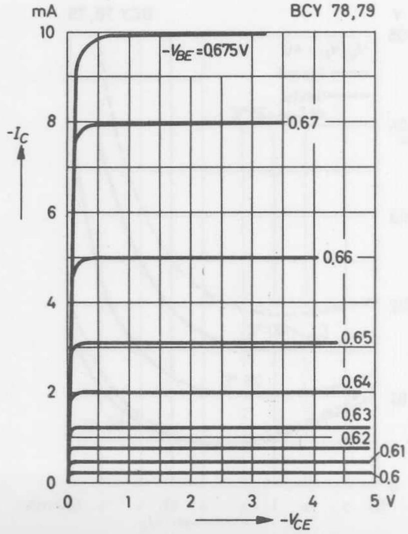

**Common emitter collector characteristics**



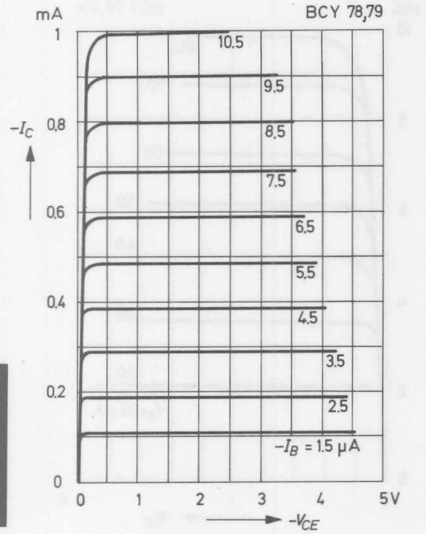

**Common emitter collector characteristics**



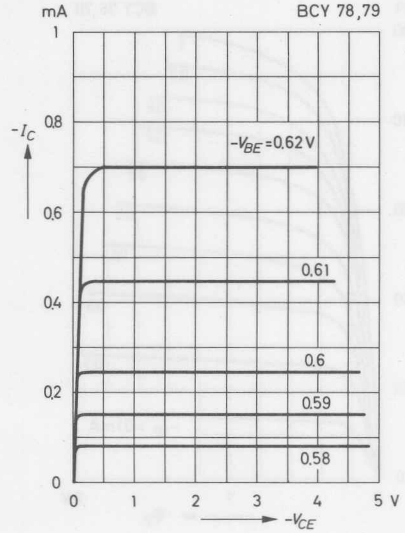

**Common emitter collector characteristics**



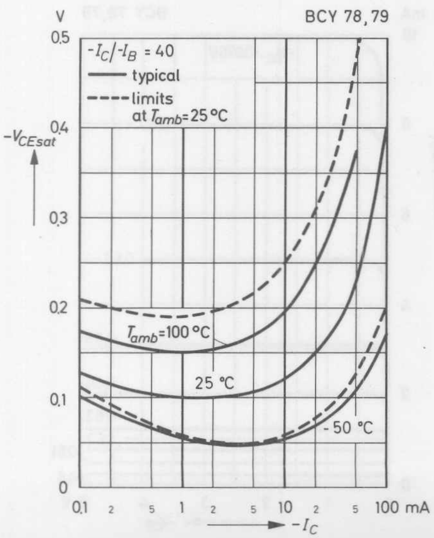
**Common emitter collector characteristics**



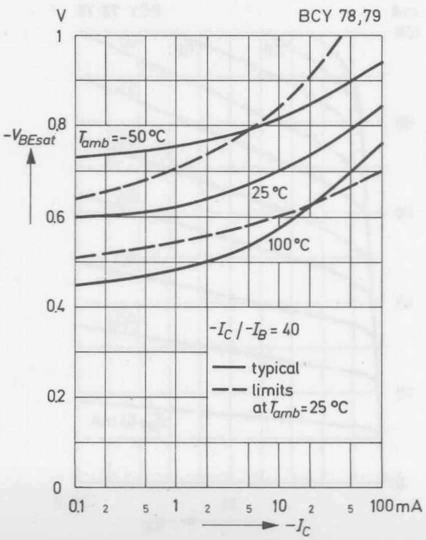

**Common emitter collector characteristics**



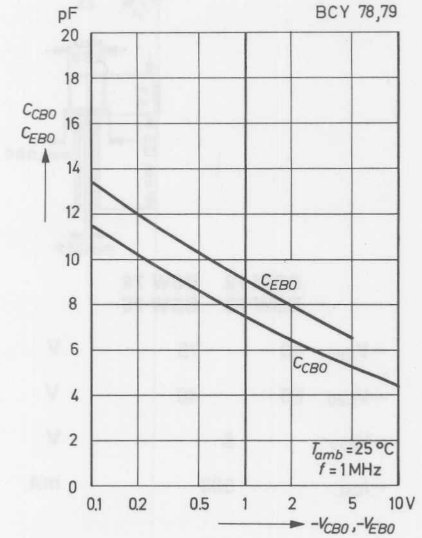

**Collector saturation voltage versus collector current**



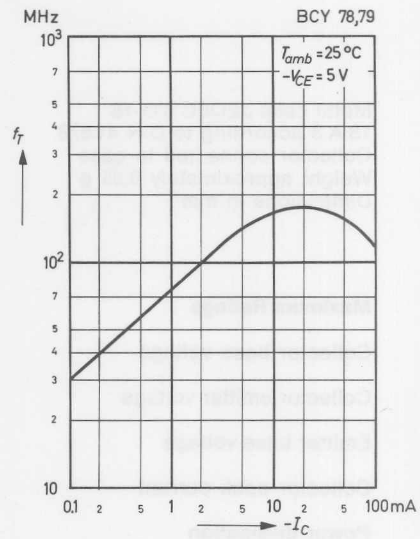

**Base saturation voltage versus collector current**



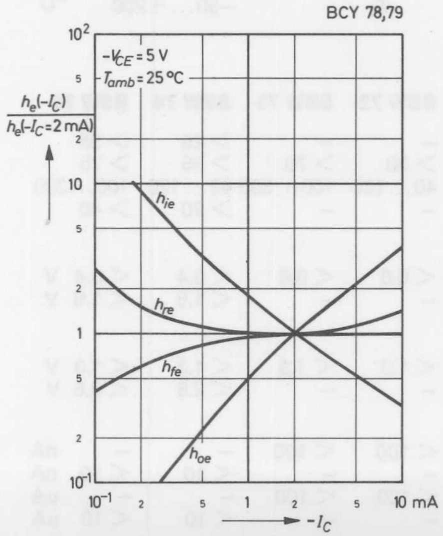
**Collector base capacitance, Emitter base capacitance versus reverse bias voltage**



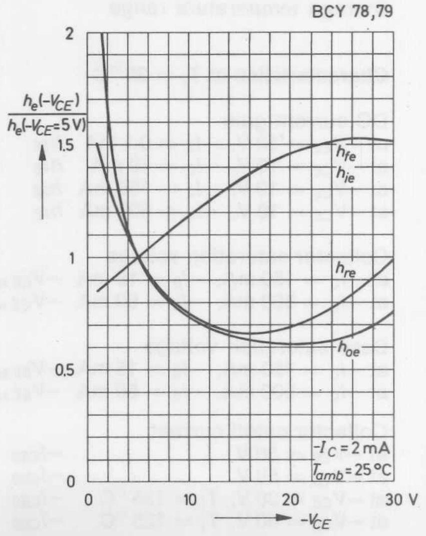

**Gain bandwidth product versus collector current**




**Relative *h*-parameters versus collector current**

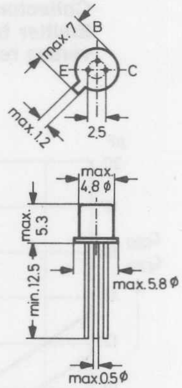



**Relative *h*-parameters versus collector emitter voltage**



# BSW 72, BSW 73, BSW 74, BSW 75

**PNP Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

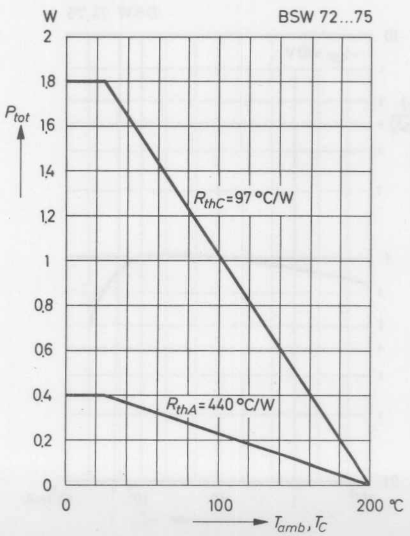
| **Maximum Ratings** | | **BSW 72 BSW 73** | **BSW 74 BSW 75** | |
|---|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 40 | 75 | V |
| Collector emitter voltage | $-V_{CE0}$ | 25 | 40 | V |
| Emitter base voltage | $-V_{EB0}$ | 5 | | V |
| Collector peak current | $-I_{CM}$ | 500 | | mA |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 400 | | mW |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1.8 | | W |
| Junction temperature | $T_j$ | 200 | | °C |
| Storage temperature range | $T_S$ | $-50 \ldots +200$ | | °C |

**Characteristics** at $T_j = 25\ °C$

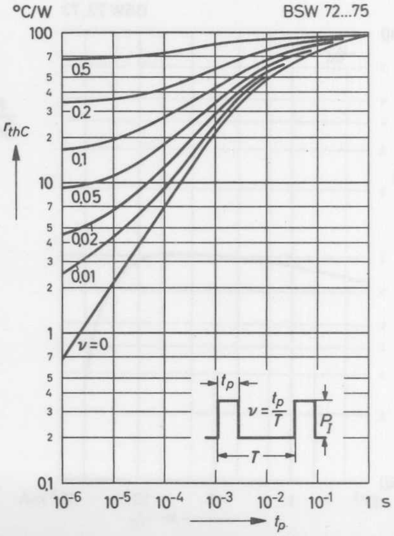
| | | **BSW 72** | **BSW 73** | **BSW 74** | **BSW 75** | |
|---|---|---|---|---|---|---|
| DC current gain | | | | | | |
| at $-V_{CE} = 10$ V, $-I_C = 0.1$ mA | $h_{FE}$ | – | – | $> 20$ | $> 35$ | |
| at $-V_{CE} = 10$ V, $-I_C = 10$ mA | $h_{FE}$ | $> 30$ | $> 70$ | $> 35$ | $> 75$ | |
| at $-V_{CE} = 10$ V, $-I_C = 150$ mA | $h_{FE}$ | 40…120 | 100…300 | 40…120 | 100…300 | |
| at $-V_{CE} = 10$ V, $-I_C = 500$ mA | $h_{FE}$ | – | – | $> 20$ | $> 40$ | |
| Collector saturation voltage | | | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | $< 0.6$ | $< 0.6$ | $< 0.4$ | $< 0.4$ | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | – | – | $< 1.6$ | $< 1.6$ | V |
| Base saturation voltage | | | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | $< 1.3$ | $< 1.3$ | $< 1.3$ | $< 1.3$ | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | – | – | $< 2.6$ | $< 2.6$ | V |
| Collector cutoff current | | | | | | |
| at $-V_{CB} = 30$ V | $-I_{CB0}$ | $< 100$ | $< 100$ | – | – | nA |
| at $-V_{CB} = 50$ V | $-I_{CB0}$ | – | – | $< 10$ | $< 10$ | nA |
| at $-V_{CB} = 30$ V, $T_j = 125\ °C$ | $-I_{CB0}$ | $< 100$ | $< 100$ | – | – | µA |
| at $-V_{CB} = 50$ V, $T_j = 125\ °C$ | $-I_{CB0}$ | – | – | $< 10$ | $< 10$ | µA |

| | | | |
|---|---|---|---|
| Emitter cutoff current at $-V_{EB} = 3$ V | $-I_{EBO}$ | < 100 | nA |
| Gain bandwidth product at $-V_{CE} = 20$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | > 150 | MHz |
| Collector base capacitance at $-V_{CBO} = 10$ V, $f = 100$ kHz | $C_{CBO}$ | < 8 | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 440 | °C/W |
| Junction to case | $R_{thC}$ | < 97 | °C/W |

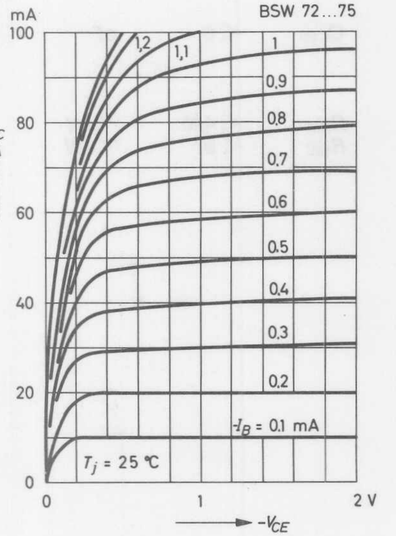
**Admissible power dissipation versus temperature**



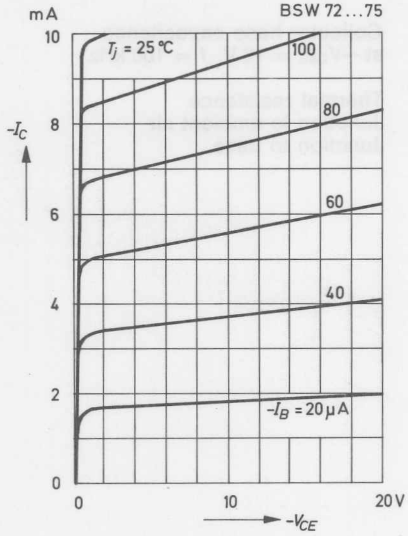

**Pulse thermal resistance versus pulse duration**



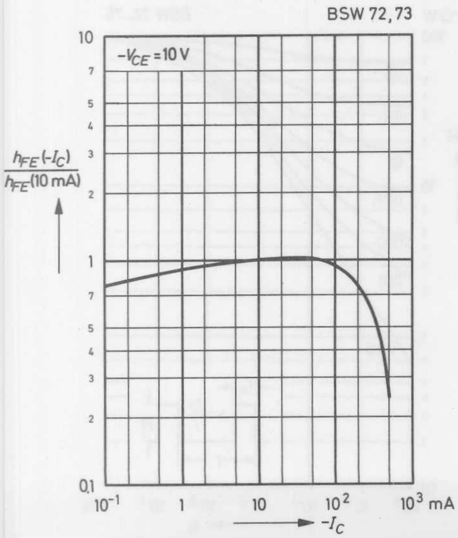
**Common emitter**
**Collector characteristics**



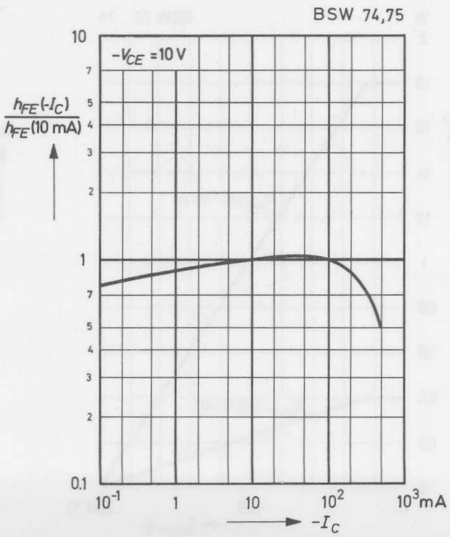

**Common emitter**
**collector characteristics**



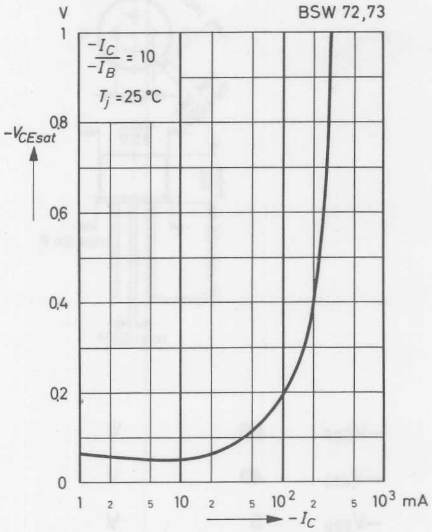

**Relative DC current gain**
**versus collector current**



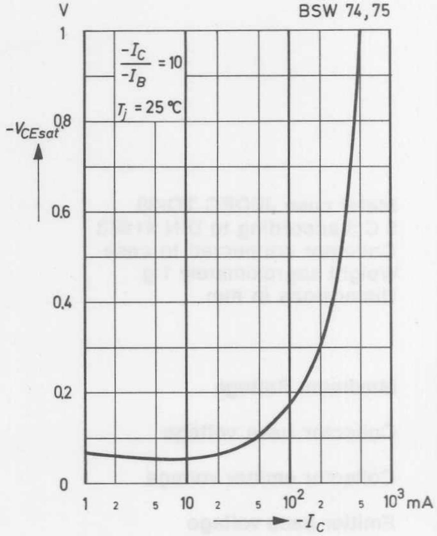

**Relative DC current gain**
**versus collector current**



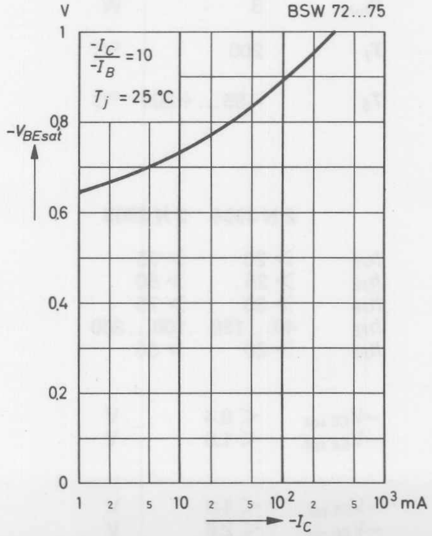
**Collector saturation voltage versus collector current**



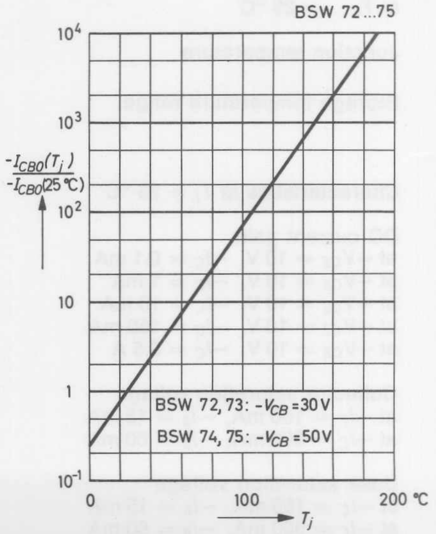

**Collector saturation voltage versus collector current**




**Base saturation voltage versus collector current**

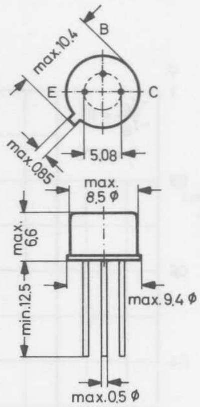



**Collector cutoff current versus junction temperature**



# 2 N 2904, 2 N 2905

**PNP Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 60 | V |
| Collector emitter voltage | $-V_{CE0}$ | 40 | V |
| Emitter base voltage | $-V_{EB0}$ | 5 | V |
| Collector current | $-I_C$ | 0.6 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +200$ | °C |

**Characteristics** at $T_j = 25\ °C$

| | | 2 N 2904 | 2 N 2905 | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $-V_{CE} = 10$ V, $-I_C = 0.1$ mA | $h_{FE}$ | $> 20$ | $> 35$ | |
| at $-V_{CE} = 10$ V, $-I_C = 1$ mA | $h_{FE}$ | $> 25$ | $> 50$ | |
| at $-V_{CE} = 10$ V, $-I_C = 10$ mA | $h_{FE}$ | $> 35$ | $> 75$ | |
| at $-V_{CE} = 10$ V, $-I_C = 150$ mA | $h_{FE}$ | $40 \ldots 120$ | $100 \ldots 300$ | |
| at $-V_{CE} = 10$ V, $-I_C = 0.5$ A | $h_{FE}$ | $> 20$ | $> 30$ | |
| Collector saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | $< 0.4$ | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | $< 1.6$ | | V |
| Base saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | $< 1.3$ | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | $< 2.6$ | | V |

| | | | |
|---|---|---|---|
| Collector cutoff current | | | |
| at $-V_{CB} = 50$ V | $-I_{CBO}$ | $< 20$ | nA |
| at $-V_{CB} = 50$ V, $T_{amb} = 150$ °C | $-I_{CBO}$ | $< 20$ | µA |
| at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{CEV}$ | $< 50$ | nA |
| Base cutoff current at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{EBV}$ | $< 50$ | nA |
| Collector base breakdown voltage at $-I_C = 10$ µA | $-V_{(BR)CBO}$ | $> 60$ | V |
| Collector emitter breakdown voltage at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | $> 40$ | V |
| Emitter base breakdown voltage at $-I_E = 10$ µA | $-V_{(BR)EBO}$ | $> 5$ | V |
| Gain bandwidth product at $-V_{CE} = 20$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | $> 200$ | MHz |
| Collector base capacitance at $-V_{CBO} = 10$ V, $f = 100$ kHz | $C_{CBO}$ | $< 8$ | pF |
| Emitter base capacitance at $-V_{EBO} = 2$ V, $f = 100$ kHz | $C_{EBO}$ | $< 30$ | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 220$ | °C/W |
| Junction to case | $R_{thC}$ | $< 58$ | °C/W |

**Switching Times**

| | | | |
|---|---|---|---|
| Delay time (see Fig. 1) | $t_d$ | 6 ($< 10$) | ns |
| Rise time (see Fig. 1) | $t_r$ | 20 ($< 40$) | ns |
| Turn-on time (see Fig. 1) | $t_{on}$ | 26 ($< 45$) | ns |
| Storage time (see Fig. 2) | $t_s$ | 50 ($< 80$) | ns |
| Fall time (see Fig. 2) | $t_f$ | 20 ($< 30$) | ns |
| Turn-off time (see Fig. 2) | $t_{off}$ | 70 ($< 100$) | ns |
| Total switching time (see Fig. 3) | $t_{total}$ | 12 | ns |

Curves and characteristics of types BSW 72 . . . 75 are valid analogously for types 2 N 2904 and 2 N 2905.

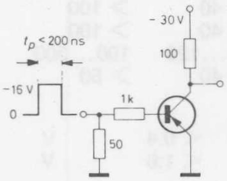



Fig. 1: Test circuit for turn-on time, saturated operation

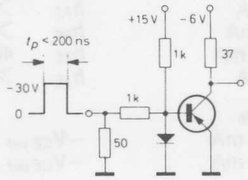



Fig. 2: Test circuit for turn-off time, saturated operation

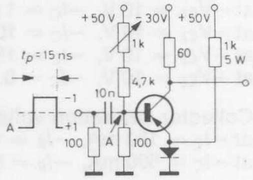
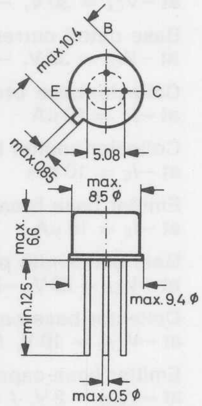



Fig. 3: Test circuit for non-saturated operation

# 2 N 2904 A, 2 N 2905 A

**PNP Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 60 | V |
| Collector emitter voltage | $-V_{CE0}$ | 60 | V |
| Emitter base voltage | $-V_{EB0}$ | 5 | V |
| Collector current | $-I_C$ | 0.6 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\,°C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\,°C$ | $P_{tot}$ | 3 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +200$ | °C |

**Characteristics** at $T_j = 25\,°C$

| | | 2 N 2904 A | 2 N 2905 A | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $-V_{CE} = 10$ V, $-I_C = 0.1$ mA | $h_{FE}$ | $> 40$ | $> 75$ | |
| at $-V_{CE} = 10$ V, $-I_C = 1$ mA | $h_{FE}$ | $> 40$ | $> 100$ | |
| at $-V_{CE} = 10$ V, $-I_C = 10$ mA | $h_{FE}$ | $> 40$ | $> 100$ | |
| at $-V_{CE} = 10$ V, $-I_C = 150$ mA | $h_{FE}$ | 40…120 | 100…300 | |
| at $-V_{CE} = 10$ V, $-I_C = 0.5$ A | $h_{FE}$ | $> 40$ | $> 50$ | |
| Collector saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | $< 0.4$ | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | $< 1.6$ | | V |
| Base saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | $< 1.3$ | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | $< 2.6$ | | V |

| | | | |
|---|---|---|---|
| Collector cutoff current | | | |
| at $-V_{CB} = 50$ V | $-I_{CBO}$ | < 10 | nA |
| at $-V_{CB} = 50$ V, $T_{amb} = 150\,°C$ | $-I_{CBO}$ | < 10 | µA |
| at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{CEV}$ | < 50 | nA |
| Base cutoff current<br>at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{EBV}$ | < 50 | nA |
| Collector base breakdown voltage<br>at $-I_C = 10$ µA | $-V_{(BR)CBO}$ | > 60 | V |
| Collector emitter breakdown voltage<br>at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | > 60 | V |
| Emitter base breakdown voltage<br>at $-I_E = 10$ µA | $-V_{(BR)EBO}$ | > 5 | V |
| Gain bandwidth product<br>at $-V_{CE} = 20$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | > 200 | MHz |
| Collector base capacitance<br>at $-V_{CB} = 10$ V, $f = 100$ kHz | $C_{CBO}$ | < 8 | pF |
| Emitter base capacitance<br>at $-V_{EB} = 2$ V, $f = 100$ kHz | $C_{EBO}$ | < 30 | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 58 | °C/W |

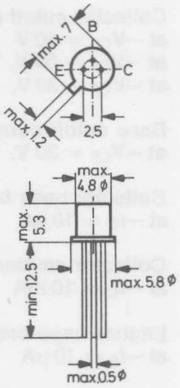
Curves and characteristics of types BSW 72 . . . 75 are valid analogously for types 2 N 2904 A and 2 N 2905 A.

**Switching Times**

Specifications for switching times of types 2 N 2904 and 2 N 2905 resp. apply to these types.

# 2 N 2906, 2 N 2907

**PNP Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 60 | V |
| Collector emitter voltage | $-V_{CE0}$ | 40 | V |
| Emitter base voltage | $-V_{EB0}$ | 5 | V |
| Collector current | $-I_C$ | 0.6 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | 0.4 | W |
| at $T_C = 25\ ^\circ C$ | $P_{tot}$ | 1.8 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | −65 ... +200 | °C |

**Characteristics** at $T_j = 25\ ^\circ C$

| | | 2 N 2906 | 2 N 2907 |
|---|---|---|---|
| DC current gain | | | |
| at $-V_{CE} = 10$ V, $-I_C = 0.1$ mA | $h_{FE}$ | > 20 | > 35 |
| at $-V_{CE} = 10$ V, $-I_C = 1$ mA | $h_{FE}$ | > 25 | > 50 |
| at $-V_{CE} = 10$ V, $-I_C = 10$ mA | $h_{FE}$ | > 35 | > 75 |
| at $-V_{CE} = 10$ V, $-I_C = 150$ mA | $h_{FE}$ | 40 ... 120 | 100 ... 300 |
| at $-V_{CE} = 10$ V, $-I_C = 0.5$ A | $h_{FE}$ | > 20 | > 30 |

| | | | |
|---|---|---|---|
| Collector saturation voltage | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | < 0.4 | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | < 1.6 | V |
| Base saturation voltage | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | < 1.3 | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | < 2.6 | V |

| | | | |
|---|---|---|---|
| Collector cutoff curent | | | |
| at $-V_{CB} = 50$ V | $-I_{CBO}$ | $< 20$ | nA |
| at $-V_{CB} = 50$ V, $T_{amb} = 150$ °C | $-I_{CBO}$ | $< 20$ | µA |
| at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{CEV}$ | $< 50$ | nA |
| Base cutoff current<br>at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{EBV}$ | $< 50$ | nA |
| Collector base breakdown voltage<br>at $-I_C = 10$ µA | $-V_{(BR)CBO}$ | $> 60$ | V |
| Collector emitter breakdown voltage<br>at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | $> 40$ | V |
| Emitter base breakdown voltage<br>at $-I_E = 10$ µA | $-V_{(BR)EBO}$ | $> 5$ | V |
| Gain bandwidth product<br>at $-V_{CE} = 20$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | $> 200$ | MHz |
| Collector base capacitance<br>at $-V_{CB} = 10$ V, $f = 100$ kHz | $C_{CBO}$ | $< 8$ | pF |
| Emitter base capacitance<br>at $-V_{EB} = 2$ V, $f = 100$ kHz | $C_{EBO}$ | $< 30$ | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 440$ | °C/W |
| Junction to case | $R_{thC}$ | $< 97$ | °C/W |

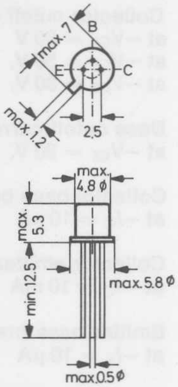
Curves and characteristics of types BSW 72 . . . 75 are valid analogously for types 2 N 2906 and 2 N 2907.

**Switching Times**

Specifications for switching times of types 2 N 2904 and 2 N 2905 resp. apply to these types.

# 2 N 2906 A, 2 N 2907 A

**PNP Silicon Epitaxial Planar Transistors**
with high cutoff frequency, for high speed switching




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 60 | V |
| Collector emitter voltage | $-V_{CE0}$ | 60 | V |
| Emitter base voltage | $-V_{EB0}$ | 5 | V |
| Collector current | $-I_C$ | 0.6 | A |
| Power dissipation at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.4 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 1.8 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | −65 . . . +200 | °C |

**Characteristics** at $T_j = 25\ °C$

| | | 2 N 2906 A | 2 N 2907 A | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $-V_{CE} = 10$ V, $-I_C = 0.1$ mA | $h_{FE}$ | > 40 | > 75 | |
| at $-V_{CE} = 10$ V, $-I_C = 1$ mA | $h_{FE}$ | > 40 | > 100 | |
| at $-V_{CE} = 10$ V, $-I_C = 10$ mA | $h_{FE}$ | > 40 | > 100 | |
| at $-V_{CE} = 10$ V, $-I_C = 150$ mA | $h_{FE}$ | 40 . . . 120 | 100 . . . 300 | |
| at $-V_{CE} = 10$ V, $-I_C = 0.5$ A | $h_{FE}$ | > 40 | > 50 | |
| Collector saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | < 0.4 | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | < 1.6 | | V |
| Base saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | < 1.3 | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | < 2.6 | | V |

| | | | |
|---|---|---|---|
| Collector cutoff curent | | | |
| at $-V_{CB} = 50$ V | $-I_{CBO}$ | $< 10$ | nA |
| at $-V_{CB} = 50$ V, $T_{amb} = 150$ °C | $-I_{CBO}$ | $< 10$ | µA |
| at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{CEV}$ | $< 50$ | nA |
| Base cutoff current at $-V_{CE} = 30$ V, $-V_{EB} = 0.5$ V | $-I_{EBV}$ | $< 50$ | nA |
| Collector base breakdown voltage at $-I_C = 10$ µA | $-V_{(BR)CBO}$ | $> 60$ | V |
| Collector emitter breakdown voltage at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | $> 60$ | V |
| Emitter base breakdown voltage at $-I_E = 10$ µA | $-V_{(BR)EBO}$ | $> 5$ | V |
| Gain bandwidth product at $-V_{CE} = 20$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | $> 200$ | MHz |
| Collector base capacitance at $-V_{CB} = 10$ V, $f = 100$ kHz | $C_{CBO}$ | $< 8$ | pF |
| Emitter base capacitance at $-V_{EB} = 2$ V, $f = 100$ kHz | $C_{EBO}$ | $< 30$ | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | $< 440$ | °C/W |
| Junction to case | $R_{thC}$ | $< 97$ | °C/W |

Curves and characteristics of types BSW 72 . . . 75 are valid analogously for types 2 N 2906 A and 2 N 2907 A.

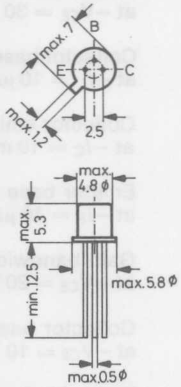
**Switching Times**

Specifications for switching times of types 2 N 2904 and 2 N 2905 resp. apply to these types.

# 2 N 3962, 2 N 3963, 2 N 3964

**PNP Silicon Planar Transistors**
designed for use in high-performance, low level, low noise amplifiers from audio to high frequency ranges. These units feature excellent DC current gain linearity from 1 μA to 50 mA.

Type 2 N 3964 offers extremely small low-frequency noise figures over a wide range of source impedances.




Metal case JEDEC TO-18
18 A 3 according to DIN 41 876
Collector connected to case
Weight approximately 0.35 g
Dimensions in mm

| **Maximum Ratings** | | **2 N 3962** | **2 N 3963** | **2 N 3964** | |
|---|---|---|---|---|---|
| Collector base voltage | $-V_{CB0}$ | 60 | 80 | 45 | V |
| Collector emitter voltage | $-V_{CE0}$ | 60 | 80 | 45 | V |
| Emitter base voltage | $-V_{EB0}$ | 6 | 6 | 6 | V |
| Power dissipation at $T_{amb} = 25\ ^\circ C$ | $P_{tot}$ | | 0.36 | | W |
| at $T_C = 25\ ^\circ C$ | $P_{tot}$ | | 1.2 | | W |
| Junction temperature | $T_j$ | | 200 | | °C |
| Storage temperature range | $T_S$ | | −65 ... +200 | | °C |

| **Static characteristics** at $T_j = 25\ ^\circ C$ | | **2 N 3962** **2 N 3963** | **2 N 3964** | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $-V_{CE} = 5$ V, $-I_C = 1$ μA | $h_{FE}$ | 175 (> 60) | 300 (> 180) | |
| at $-V_{CE} = 5$ V, $-I_C = 10$ μA | $h_{FE}$ | 210 (100 ... 300) | 320 (250 ... 500) | |
| at $-V_{CE} = 5$ V, $-I_C = 100$ μA | $h_{FE}$ | 240 (> 100) | 330 (> 250) | |
| at $-V_{CE} = 5$ V, $-I_C = 1$ mA | $h_{FE}$ | 260 (100 ... 450) | 330 (250 ... 600) | |
| at $-V_{CE} = 5$ V, $-I_C = 10$ mA | $h_{FE}$ | 280 (> 100) | 330 (> 200) | |
| at $-V_{CE} = 5$ V, $-I_C = 50$ mA | $h_{FE}$ | 260 (> 90) | 315 (> 180) | |
| at $-V_{CE} = 5$ V, $-I_C = 10$ μA, $T_j = -55\ ^\circ C$ | $h_{FE}$ | 90 (> 40) | 160 (> 100) | |
| at $-V_{CE} = 5$ V, $-I_C = 50$ mA, $T_j = -55\ ^\circ C$ | $h_{FE}$ | 150 (> 45) | 190 (> 90) | |
| at $-V_{CE} = 5$ V, $-I_C = 1$ mA, $T_j = 100\ ^\circ C$ | $h_{FE}$ | 375 (< 600) | 400 (< 800) | |
| Collector saturation voltage | | | | |
| at $-I_C = 10$ mA, $-I_B = 0.5$ mA | $-V_{CE\,sat}$ | 0.1 (< 0.25) | | V |
| at $-I_C = 50$ mA, $-I_B = 5$ mA | $-V_{CE\,sat}$ | 0.16 (< 0.4) | | V |
| Base saturation voltage | | | | |
| at $-I_C = 10$ mA, $-I_B = 0.5$ mA | $-V_{BE\,sat}$ | 0.72 (< 0.9) | | V |
| at $-I_C = 50$ mA, $-I_B = 5$ mA | $-V_{BE\,sat}$ | 0.81 (< 0.95) | | V |

| | | 2 N 3962 | 2 N 3963 | 2 N 3964 | |
|---|---|---|---|---|---|
| Collector cutoff current | | | | | |
| at $-V_{CE} = 40$ V | $-I_{CES}$ | – | – | 0.5 (< 10) | nA |
| at $-V_{CE} = 50$ V | $-I_{CES}$ | 0.5 (< 10) | – | – | nA |
| at $-V_{CE} = 70$ V | $-I_{CES}$ | – | 0.5 (< 10) | – | nA |
| at $-V_{CE} = 40$ V, $T_j = 150$ °C | $-I_{CES}$ | – | – | 2 (< 10) | μA |
| at $-V_{CE} = 50$ V, $T_j = 150$ °C | $-I_{CES}$ | 2 (< 10) | – | – | μA |
| at $-V_{CE} = 70$ V, $T_j = 150$ °C | $-I_{CES}$ | – | 2 (< 10) | – | μA |
| Emitter cutoff current at $-V_{EB} = 4$ V | $-I_{EB0}$ | < 10 | < 10 | < 10 | nA |
| Collector base breakdown voltage at $-I_C = 10$ μA | $-V_{(BR)CB0}$ | > 60 | > 80 | > 45 | V |
| Collector emitter breakdown voltage | | | | | |
| at $-I_C = 10$ μA | $-V_{(BR)CES}$ | > 60 | > 80 | > 45 | V |
| at $-I_C = 5$ mA | $-V_{(BR)CE0}$ | > 60 | > 80 | > 45 | V |
| Emitter base breakdown voltage at $-I_E = 10$ μA | $-V_{(BR)EB0}$ | > 6 | > 6 | > 6 | V |
| Thermal resistance | | | | | |
| Junction to ambient air | $R_{thA}$ | | < 480 | | °C/W |
| Junction to case | $R_{thC}$ | | < 150 | | °C/W |

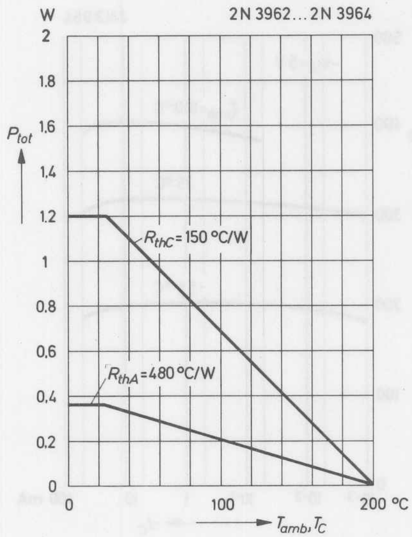
**Dynamic characteristics** at $T_{amb} = 25$ °C

| | | | |
|---|---|---|---|
| Collector base capacitance at $-V_{CB0} = 5$ V | $C_{CB0}$ | < 6 | pF |
| Emitter base capacitance at $-V_{EB0} = 0.5$ V | $C_{EB0}$ | < 15 | pF |
| Gain bandwidth product at $-V_{CE} = 5$ V, $-I_C = 0.5$ mA, $f = 20$ MHz | | | |
| **2 N 3962 and 2 N 3963** | $f_T$ | > 40 | MHz |
| **2 N 3964** | $f_T$ | > 50 | MHz |

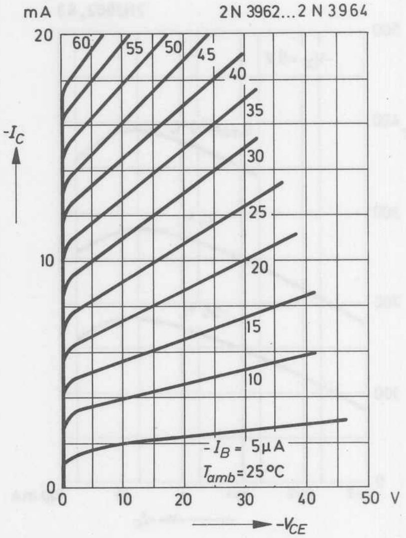
| $h$-parameters at $-V_{CE} = 5$ V, $-I_C = 1$ mA, $f = 1$ kHz | | **2 N 3962 2 N 3963** | **2 N 3964** | |
|---|---|---|---|---|
| Small signal current gain | $h_{fe}$ | 300 (100 . . . 550) | 360 (250 . . . 700) | |
| Input impedance | $h_{ie}$ | 8 (2.5 . . . 17) | 10 (6 . . . 20) | kΩ |
| Output admittance | $h_{oe}$ | 19 (5 . . . 40) | 25 (5 . . . 50) | μmho |
| Reverse voltage transfer ratio | $h_{re}$ | $< 10 \cdot 10^{-4}$ | $< 10 \cdot 10^{-4}$ | |

| | | 2 N 3962<br>2 N 3963 | 2 N 3964 | |
|---|---|---|---|---|
| Noise figure | | | | |
| at $-V_{CE} = 5$ V, $-I_C = 20$ µA, $R_G = 10$ kΩ | | | | |
| at $\Delta f = 30$ Hz . . . 15 kHz | $F$ | 1 (< 3) | 0.7 (< 2) | dB |
| at $f = 10$ Hz | $F$ | – | 3.5 (< 8) | dB |
| at $f = 120$ Hz | $F$ | 3 (< 10) | 1.8 (< 4) | dB |
| at $f = 1$ kHz | $F$ | 0.8 (< 3) | 0.5 (< 2) | dB |
| at $f = 10$ kHz | $F$ | 0.8 (< 3) | 0.5 (< 2) | dB |

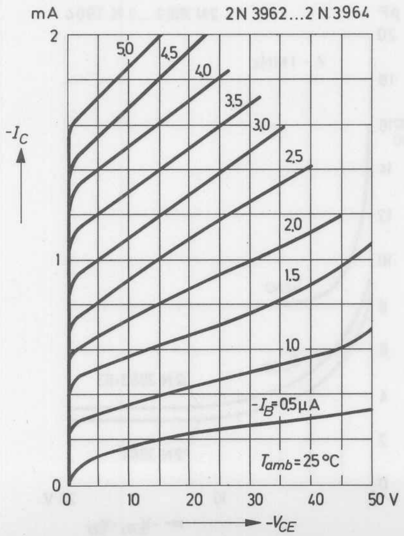
**Admissible power dissipation versus temperature**



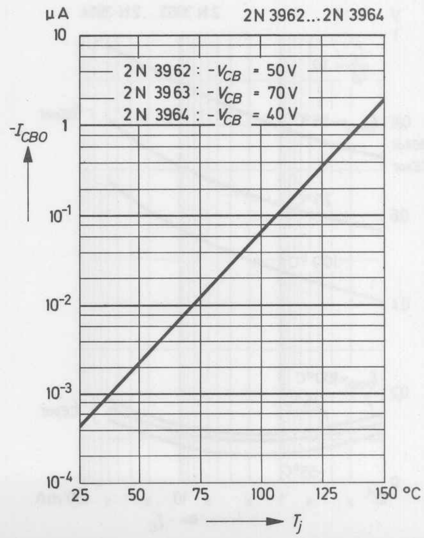

**Common emitter collector characteristics**



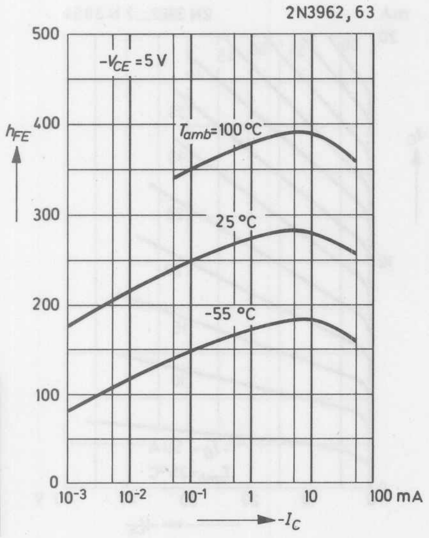

**Common emitter collector characteristics**



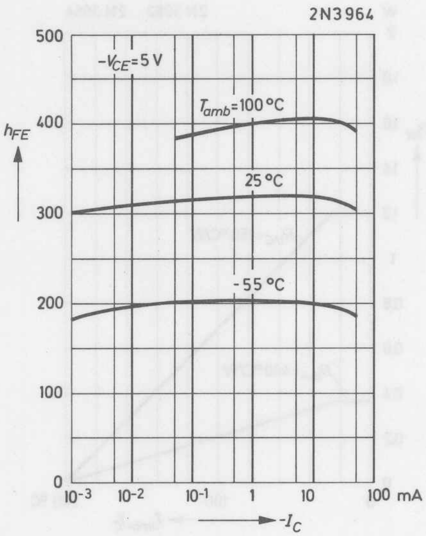

**Collector cutoff current versus junction temperature**



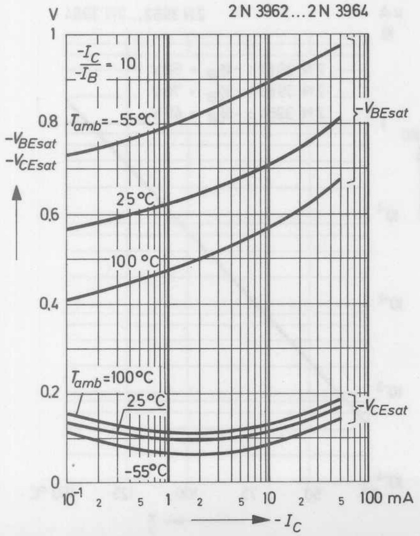
**DC current gain versus collector current**



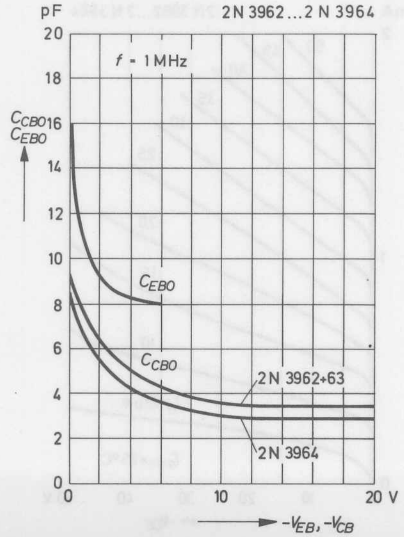

**DC current gain versus collector current**



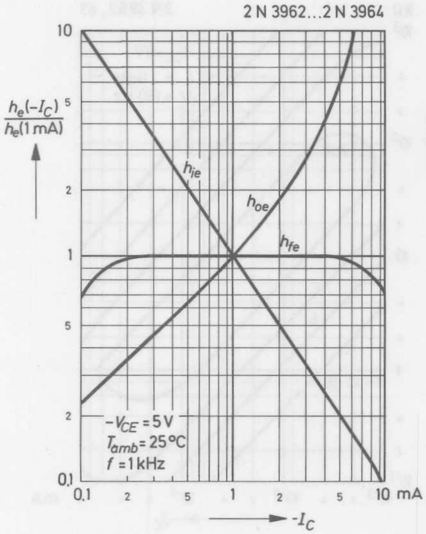

**Collector saturation voltage**
**Base saturation voltage**
**versus collector current**



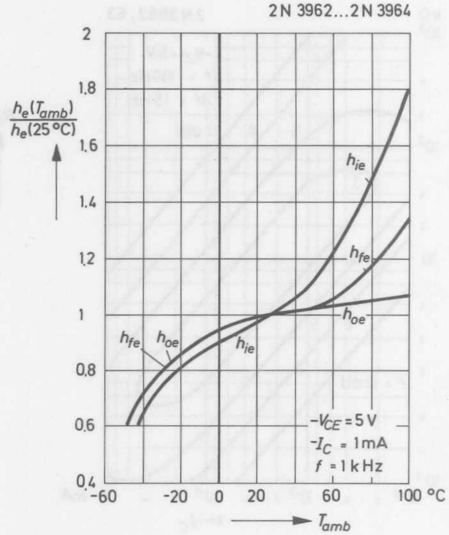

**Collector base capacitance,**
**Emitter base capacitance**
**versus reverse bias voltage**



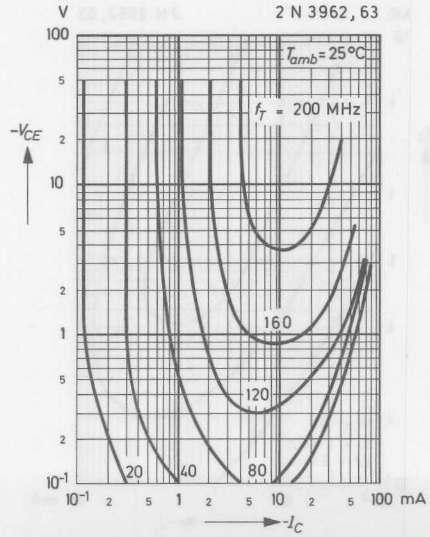
**Relative h-parameters versus collector current**



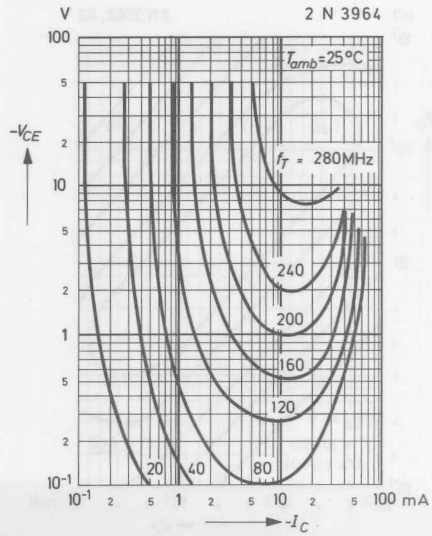

**Relative h-parameters versus ambient temperature**



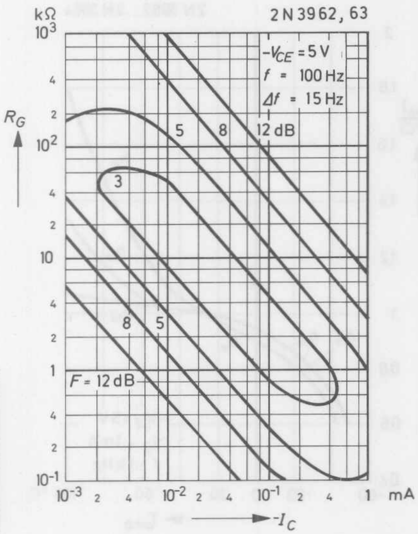

**Contours of constant gain bandwidth product**



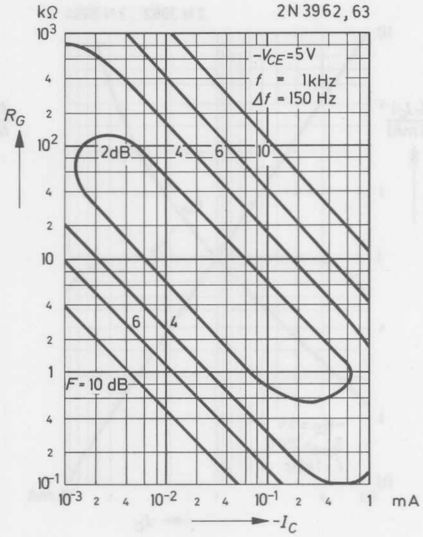

**Contours of constant gain bandwidth product**



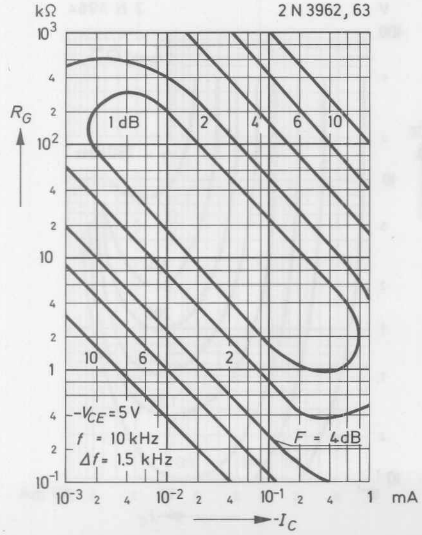
**Contours of constant narrow band noise figure**



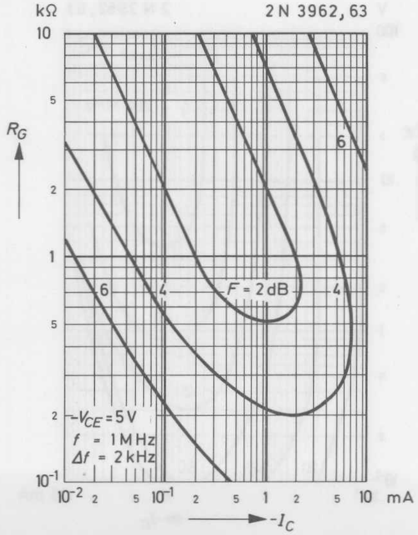

**Contours of constant narrow band noise figure**



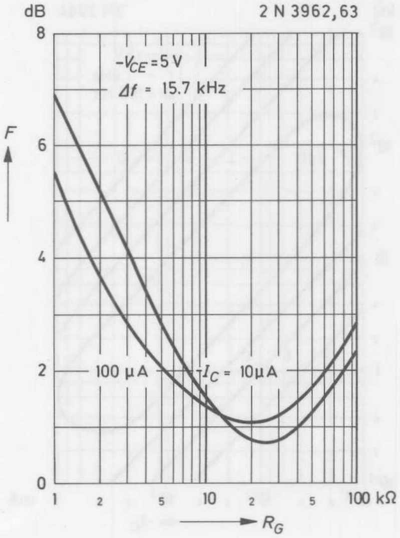

**Contours of constant narrow band noise figure**



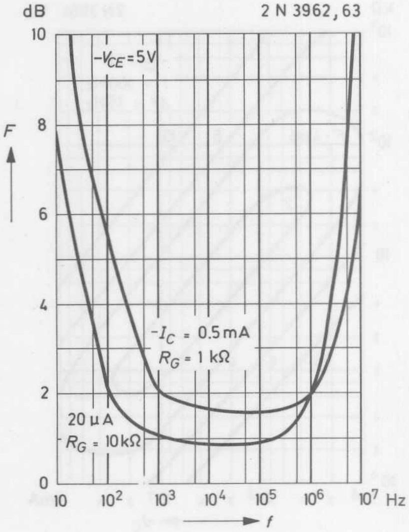

**Contours of constant narrow band noise figure**



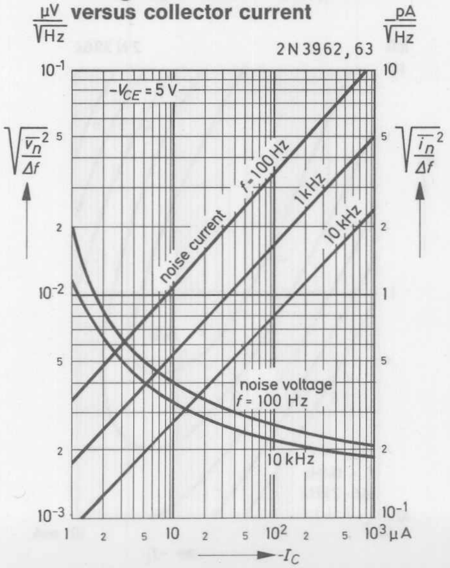
**Wide band noise figure versus generator resistance**



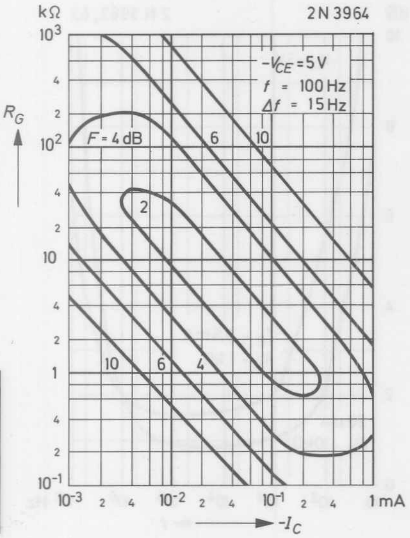

**Noise figure versus frequency**



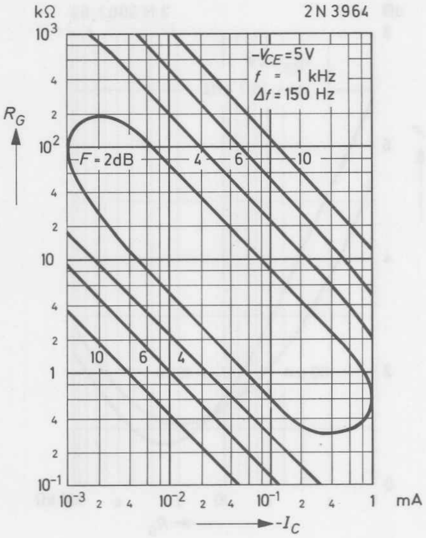

**Equivalent input noise voltage and noise current versus collector current**



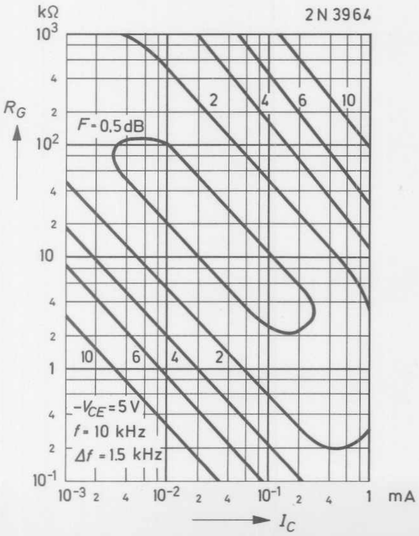
**Contours of constant narrow band noise figure**



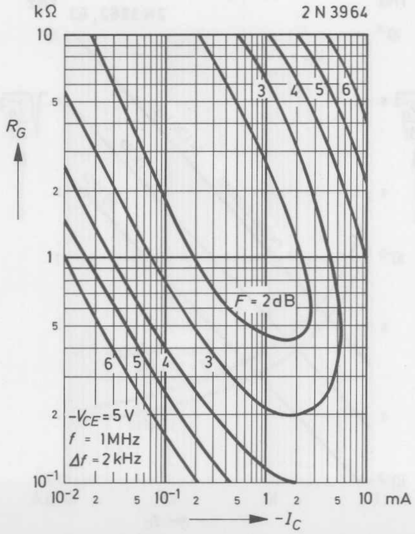

**Contours of constant narrow band noise figure**



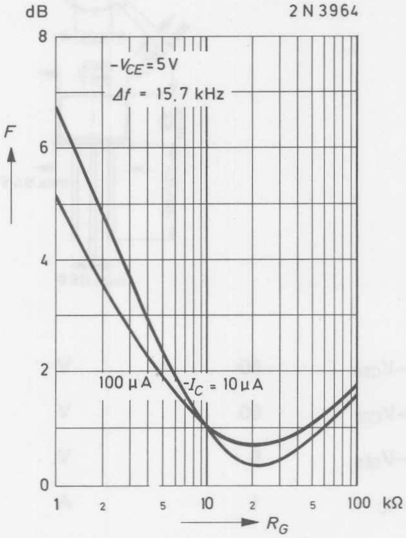

**Contours of constant narrow band noise figure**



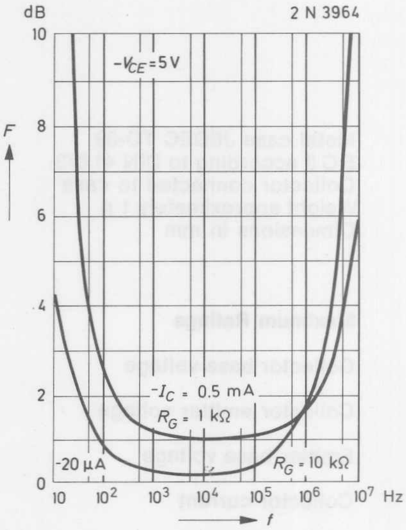

**Contours of constant narrow band noise figure**



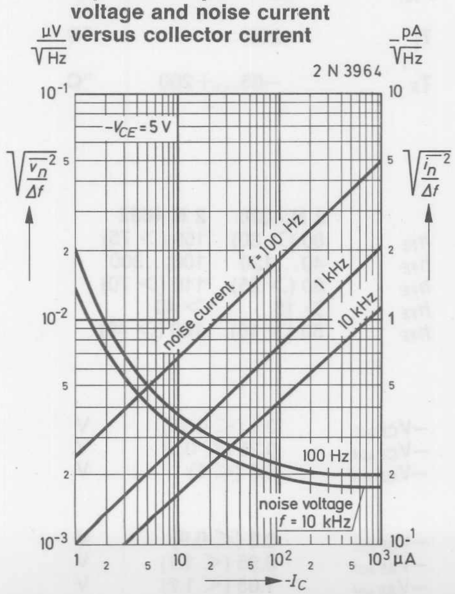
**Wide band noise figure versus generator resistance**




**Noise figure versus frequency**

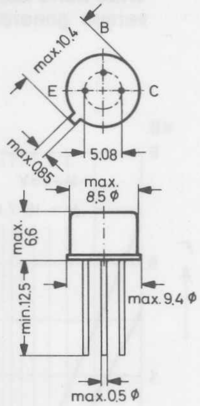



**Equivalent input noise voltage and noise current versus collector current**



# 2 N 4030, 2 N 4032

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications from DC to RF




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 60 | V |
| Collector emitter voltage | $-V_{CEO}$ | 60 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | V |
| Collector current | $-I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 4 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +200$ | °C |

**Characteristics** at $T_j = 25\ °C$

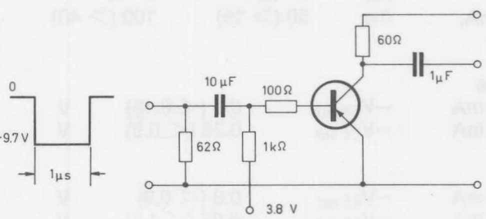
| | | 2 N 4030 | 2 N 4032 | |
|---|---|---|---|---|
| DC current gain | | | | |
| at $-V_{CE} = 5$ V, $-I_C = 100\ \mu A$ | $h_{FE}$ | 80 (> 30) | 150 (> 75) | |
| at $-V_{CE} = 5$ V, $-I_C = 100$ mA | $h_{FE}$ | 40…120 | 100…300 | |
| at $-V_{CE} = 5$ V, $-I_C = 0.5$ A | $h_{FE}$ | 60 (> 25) | 110 (> 70) | |
| at $-V_{CE} = 5$ V, $-I_C = 1$ mA | $h_{FE}$ | > 15 | > 40 | |
| at $-V_{CE} = 5$ V, $-I_C = 100$ mA, $T_j = -55\ °C$ | $h_{FE}$ | 50 (> 15) | 100 (> 40) | |
| Collector saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | 0.1 (< 0.15) | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | 0.25 (< 0.5) | | V |
| at $-I_C = 1$ A, $-I_B = 100$ mA | $-V_{CE\,sat}$ | 0.5 (< 1) | | V |
| Base saturation voltage | | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | 0.8 (< 0.9) | | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | 0.95 (< 1.1) | | V |
| at $-I_C = 1$ A, $-I_B = 100$ mA | $-V_{BE\,sat}$ | 1.05 (< 1.2) | | V |

| | | | |
|---|---|---|---|
| Collector cutoff current | | | |
| at $-V_{CB} = 50$ V | $-I_{CBO}$ | 0.2 (< 50) | nA |
| at $-V_{CB} = 50$ V, $T_j = 150$ °C | $-I_{CBO}$ | 0.2 (< 50) | µA |
| Emitter cutoff current<br>at $-V_{EB} = 5$ V | $-I_{EBO}$ | < 10 | µA |
| Collector base breakdown voltage<br>at $-I_C = 10$ µA | $-V_{(BR)CBO}$ | > 60 | V |
| Collector emitter breakdown voltage<br>at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | > 60 | V |
| Emitter base breakdown voltage<br>at $-I_E = 10$ µA | $-V_{(BR)EBO}$ | > 5 | V |
| Gain bandwidth product<br>at $-V_{CE} = 10$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | 150 (> 100) | MHz |
| Collector base capacitance<br>at $-V_{CBO} = 10$ V | $C_{CBO}$ | 15 (< 20) | pF |
| Emitter base capacitance<br>at $-V_{EBO} = 0.5$ V | $C_{EBO}$ | 75 (< 110) | pF |
| Thermal resistance | | | |
| Junction to ambient air | $R_{thA}$ | < 220 | °C/W |
| Junction to case | $R_{thC}$ | < 44 | °C/W |

Curves and characteristics of types BC 160 and BC 161 are valid analogously for types 2 N 4030 and 2 N 4032.

**Switching Times**

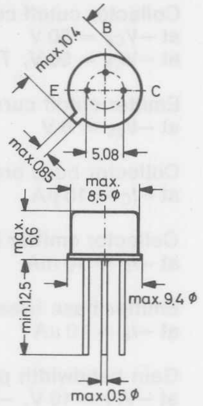
| | | | |
|---|---|---|---|
| Turn-on time<br>at $-I_C = 500$ mA, $-I_{B1} = 50$ mA | $t_{on}$ | 27 (< 100) | ns |
| Storage time<br>at $-I_C = 500$ mA, $-I_{B1} = 50$ mA, $I_{B2} = 50$ mA | $t_s$ | 160 (< 350) | ns |
| Fall time<br>at $-I_C = 500$ mA, $-I_{B1} = 50$ mA, $I_{B2} = 50$ mA | $t_f$ | 23 (< 50) | ns |




**Test Circuit for Switching Times**

# 2 N 4030, 2 N 4032

**PNP Silicon Epitaxial Planar Transistors**
for switching and amplifier applications from DC to RF




Metal case JEDEC TO-39
5 C 3 according to DIN 41 873
Collector connected to case
Weight approximately 1 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 80 | V |
| Collector emitter voltage | $-V_{CEO}$ | 80 | V |
| Emitter base voltage | $-V_{EBO}$ | 5 | V |
| Collector current | $-I_C$ | 1 | A |
| Power dissipation | | | |
| at $T_{amb} = 25\ °C$ | $P_{tot}$ | 0.8 | W |
| at $T_C = 25\ °C$ | $P_{tot}$ | 4 | W |
| Junction temperature | $T_j$ | 200 | °C |
| Storage temperature range | $T_S$ | $-65 \ldots +200$ | °C |

**Characteristics** at $T_j = 25\ °C$

| | | **2 N 4031** | **2 N 4033** |
|---|---|---|---|
| DC current gain | | | |
| at $-V_{CE} = 5$ V, $-I_C = 100$ μA | $h_{FE}$ | 80 (> 30) | 150 (> 75) |
| at $-V_{CE} = 5$ V, $-I_C = 100$ mA | $h_{FE}$ | 40 … 120 | 100 … 300 |
| at $-V_{CE} = 5$ V, $-I_C = 0.5$ A | $h_{FE}$ | 60 (> 25) | 110 (> 70) |
| at $-V_{CE} = 5$ V, $-I_C = 1$ A | $h_{FE}$ | > 15 | > 40 |
| at $-V_{CE} = 5$ V, $-I_C = 100$ mA, $T_j = -55\ °C$ | $h_{FE}$ | 50 (> 15) | 100 (> 40) |

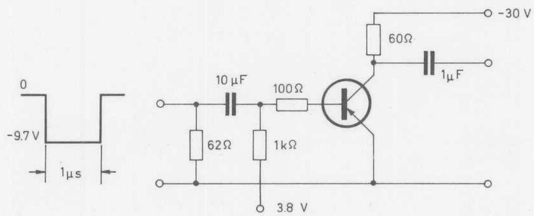
| | | | |
|---|---|---|---|
| Collector saturation voltage | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{CE\,sat}$ | 0.1 (< 0.15) | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{CE\,sat}$ | 0.25 (< 0.5) | V |
| Base saturation voltage | | | |
| at $-I_C = 150$ mA, $-I_B = 15$ mA | $-V_{BE\,sat}$ | 0.8 (< 0.9) | V |
| at $-I_C = 500$ mA, $-I_B = 50$ mA | $-V_{BE\,sat}$ | 0.95 (< 1.1) | V |

| | | | |
|---|---|---|---|
| Collector cutoff current<br>at $-V_{CB} = 50$ V<br>at $-V_{CB} = 50$ V, $T_j = 150$ °C | <br>$-I_{CB0}$<br>$-I_{CB0}$ | <br>0.2 (< 50)<br>0.2 (< 50) | <br>nA<br>μA |
| Emitter cutoff current<br>at $-V_{EB} = 5$ V | $-I_{EB0}$ | < 10 | μA |
| Collector base breakdown voltage<br>at $-I_C = 10$ μA | $-V_{(BR)CB0}$ | > 80 | V |
| Collector emitter breakdown voltage<br>at $-I_C = 10$ mA | $-V_{(BR)CE0}$ | > 80 | V |
| Emitter base breakdown voltage<br>at $-I_E = 10$ μA | $-V_{(BR)EB0}$ | > 5 | V |
| Gain bandwidth product<br>at $-V_{CE} = 10$ V, $-I_C = 50$ mA, $f = 100$ MHz | $f_T$ | 150 (> 100) | MHz |
| Collector base capacitance<br>at $-V_{CB0} = 10$ V | $C_{CB0}$ | 15 (< 20) | pF |
| Emitter base capacitance<br>at $-V_{EB0} = 0.5$ V | $C_{EB0}$ | 75 (< 110) | pF |
| Thermal resistance<br>Junction to ambient air<br>Junction to case | <br>$R_{thA}$<br>$R_{thC}$ | <br>< 220<br>< 44 | <br>°C/W<br>°C/W |

Curves and characteristics of types BC 160 and BC 161 are valid analogously for types 2 N 4031 and 2 N 4033.

**Switching Times**

| | | | |
|---|---|---|---|
| Turn-on time<br>at $-I_C = 500$ mA, $-I_{B1} = 50$ mA | $t_{on}$ | 27 (< 100) | ns |
| Storage time<br>at $-I_C = 500$ mA, $-I_{B1} = 50$ mA, $I_{B2} = 50$ mA | $t_s$ | 160 (< 350) | ns |
| Fall time<br>at $-I_C = 500$ mA, $-I_{B1} = 50$ mA, $I_{B2} = 50$ mA | $t_f$ | 23 (< 50) | ns |

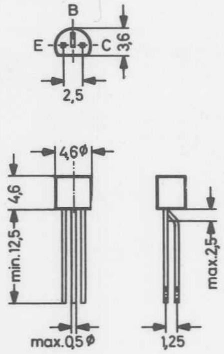



**Test Circuit for Switching Times**

PNP Silicon
High Frequency Transistors

# BF 324

**PNP Silicon Epitaxial Planar Transistor**
with extremely small feedback capacitance, designed for base-grounded FM RF amplifiers in the range of 100 MHz




Plastic case ≈ JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 30 | V |
| Collector emitter voltage | $-V_{CEO}$ | 30 | V |
| Emitter base voltage | $-V_{EBO}$ | 4 | V |
| Collector current | $-I_C$ | 25 | mA |
| Base current | $-I_B$ | 5 | mA |
| Power dissipation at $T_{amb} = 45\,°C$ | $P_{tot}$ | 250 [1] | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | $-55\ldots+150$ | °C |

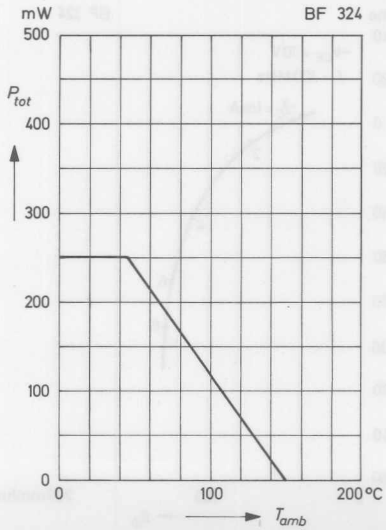
**Characteristics** at $T_{amb} = 25\,°C$

| | | | |
|---|---|---|---|
| DC current gain<br>at $-V_{CE} = 10$ V, $-I_C = 1$ mA<br>at $-V_{CE} = 10$ V, $-I_C = 4$ mA | <br>$h_{FE}$<br>$h_{FE}$ | <br>45<br>50 (25 . . . 160) | |
| Base emitter voltage<br>at $-V_{CE} = 10$ V, $-I_C = 4$ mA | $-V_{BE}$ | 0.76 | V |
| Collector emitter breakdown voltage<br>at $-I_C = 10$ mA | $-V_{(BR)CEO}$ | $> 30$ | V |
| Emitter base breakdown voltage<br>at $-I_E = 10\,\mu A$ | $-V_{(BR)EBO}$ | $> 4$ | V |
| Collector cutoff current<br>at $-V_{CB} = 30$ V | $-I_{CBO}$ | $< 50$ | nA |
| Thermal resistance<br>Junction to ambient air | $R_{thA}$ | $< 420$ [1] | °C/W |

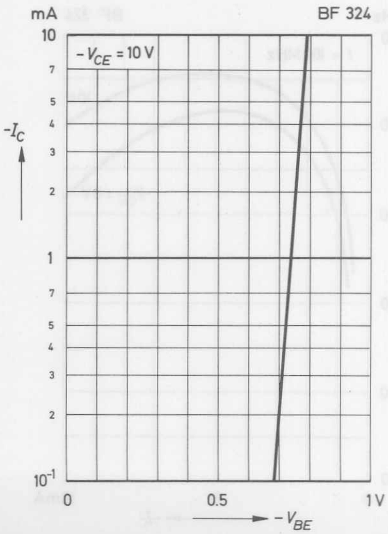
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | |
|---|---|---|---|
| Gain bandwidth product at $f = 100$ MHz | | | |
| at $-V_{CE} = 10$ V, $-I_C = 1$ mA | $f_T$ | 350 | MHz |
| at $-V_{CE} = 10$ V, $-I_C = 4$ mA | $f_T$ | 450 | MHz |
| at $-V_{CE} = 10$ V, $-I_C = 8$ mA | $f_T$ | 440 | MHz |
| Feedback capacitance at $-V_{CB} = 10$ V, $V_{BE} = 0$, $f = 1$ MHz | $C_{rb}$ | 0.1 | pF |
| Noise figure at $-V_{CE} = 10$ V, $-I_C = 2$ mA, $f = 100$ MHz, $R_G = 60\ \Omega$ | $F$ | 3 | dB |

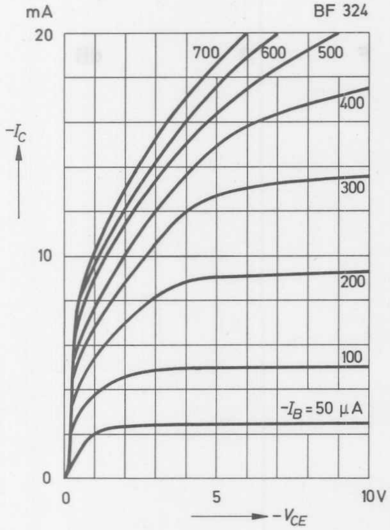
**Admissible power dissipation versus ambient temperature**
(see note on previous page)



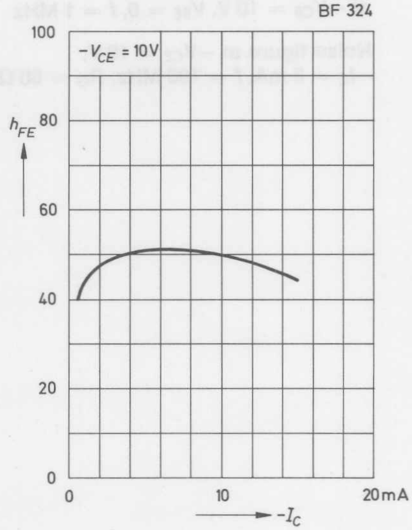

**Collector current versus base emitter voltage**



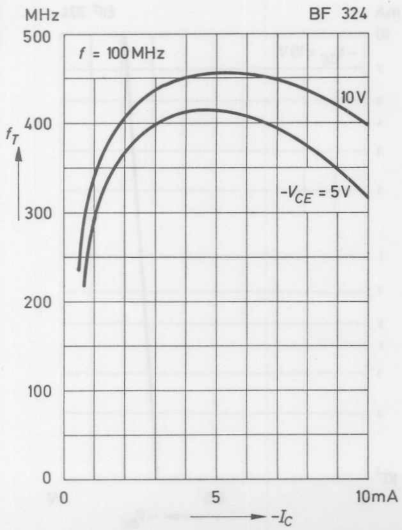
### Common emitter collector characteristics



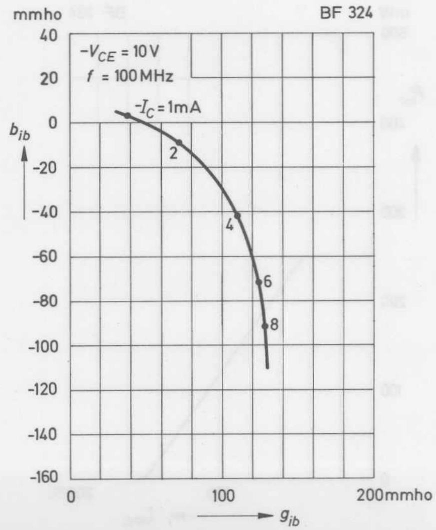

### DC current gain versus collector current



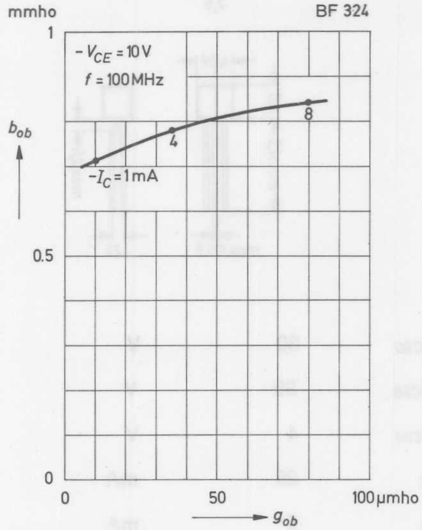

### Gain bandwidth product versus collector current



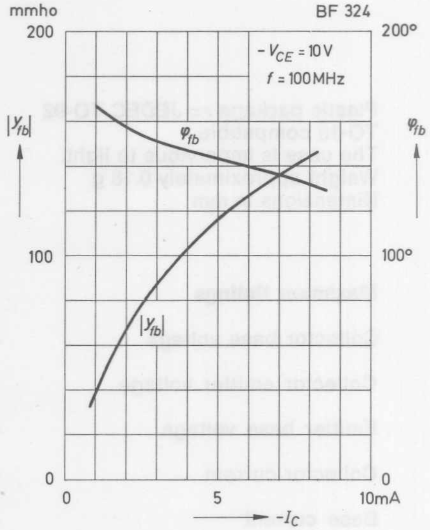

### Input admittance characteristic



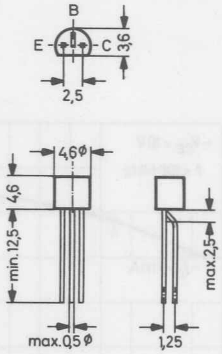
**Output admittance characteristic**




**Forward transconductance versus collector current**



**PNP Silicon Epitaxial Planar VHF Transistor**
for base-grounded VHF amplifiers and mixers




Plastic package ≈ JEDEC TO-92
TO-18 compatible
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 30 | V |
| Collector emitter voltage | $-V_{CEO}$ | 30 | V |
| Emitter base voltage | $-V_{EBO}$ | 4 | V |
| Collector current | $-I_C$ | 25 | mA |
| Base current | $-I_B$ | 5 | mA |
| Power dissipation at $T_{amb} = 45\ °C$ | $P_{tot}$ | 250 [1]) | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +150$ | °C |

**Characteristics** at $T_{amb} = 25\ °C$

| | | | |
|---|---|---|---|
| DC current gain at $-V_{CE} = 10$ V, $-I_C = 1$ mA | $h_{FE}$ | 45 | |
| at $-V_{CE} = 10$ V, $-I_C = 4$ mA | $h_{FE}$ | 50 (25 . . . 260) | |
| Base emitter voltage at $-V_{CE} = 10$ V, $-I_C = 4$ mA | $-V_{BE}$ | 0.76 | V |
| Collector emitter breakdown voltage at $-I_C = 10$ mA | $-V_{(BR)\,CEO}$ | $> 30$ | V |
| Emitter base breakdown voltage at $-I_E = 10\ \mu A$ | $-V_{(BR)\,EBO}$ | $> 4$ | V |
| Collector cutoff current at $-V_{CB} = 30$ V | $-I_{CBO}$ | $< 50$ | nA |
| Thermal resistance Junction to ambient air | $R_{thA}$ | $< 420$ [1]) | °C/W |

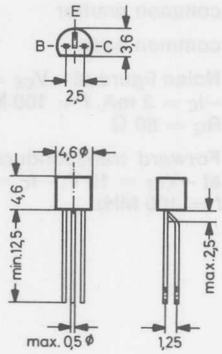
[1]) Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | |
|---|---|---|---|
| Gain bandwidth product | | | |
| at $-V_{CE} = 10$ V, $-I_C =$ mA | $f_T$ | 300 | MHz |
| at $-V_{CE} = 10$ V, $-I_C = 4$ mA | $f_T$ | 500 | MHz |
| Feedback capacitance<br>at $-V_{CE} = 10$ V, $I_C = 0$, $f = 1$ MHz | | | |
| common emitter | $-C_{12e}$ | 0.65 | pF |
| common base | $-C_{12b}$ | 0.3 | pF |
| Noise figure at $-V_{CE} = 10$ V,<br>$-I_C = 2$ mA, $f = 100$ MHz,<br>$R_G = 60\ \Omega$ | $F$ | 3 | dB |
| Forward transconductance<br>at $-V_{CE} = 10$ V, $-I_C = 1$ mA,<br>$f = 100$ MHz | $y_{21b}$ | $> 33$ | mmho |

# BF 450, BF 451

**PNP Silicon Epitaxial Planar Transistors**
designed for emitter-grounded AM and FM IF amplifier stages in which the negative pole of the supply voltage is grounded.

The BF 450 is designed for stages with AGC, and the BF 451 is designed for stages without AGC.




Plastic case ≈ JEDEC TO-92
TO-18 compatible.
The case is impervious to light.
Weight approximately 0.18 g
Dimensions in mm

**Maximum Ratings**

| | | | |
|---|---|---|---|
| Collector base voltage | $-V_{CBO}$ | 40 | V |
| Collector emitter voltage | $-V_{CEO}$ | 40 | V |
| Emitter base voltage | $-V_{EBO}$ | 4 | V |
| Collector current | $-I_C$ | 25 | mA |
| Base current | $-I_B$ | 5 | mA |
| Power dissipation at $T_{amb} < 60$ °C | $P_{tot}$ | 150 [1] | mW |
| Junction temperature | $T_j$ | 150 | °C |
| Storage temperature range | $T_S$ | $-55 \ldots +150$ | °C |

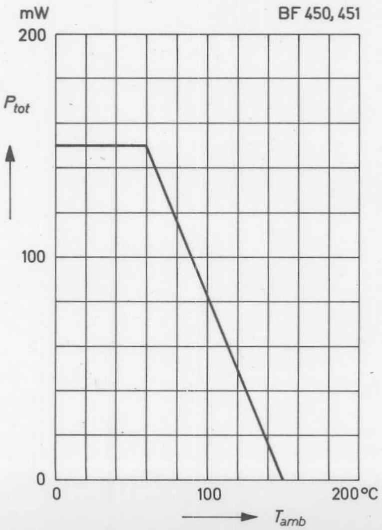
**Characteristics** at $T_{amb} = 25$ °C

| | | | | |
|---|---|---|---|---|
| DC current gain at $-V_{CE} = 10$ V, $-I_C = 1$ mA | **BF 450** | $h_{FE}$ | $> 60$ | |
| | **BF 451** | $h_{FE}$ | $> 30$ | |
| Collector base breakdown voltage at $-I_C = 10$ µA | | $-V_{(BR)CBO}$ | $> 40$ | V |
| Collector emitter breakdown voltage at $-I_C = 2$ mA | | $-V_{(BR)CEO}$ | $> 40$ | V |
| Thermal resistance Junction to ambient air | | $R_{thA}$ | $< 600$ [1] | °C/W |

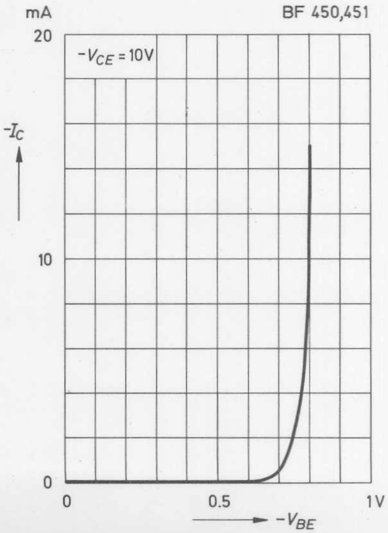
[1] Valid provided that leads are kept at ambient temperature at a distance of 2 mm from case.

| | | | |
|---|---|---|---|
| Collector cutoff current<br>at $-V_{CB} = 30$ V | $-I_{CBO}$ | $< 50$ | nA |
| Gain bandwidth product<br>at $-V_{CE} = 10$ V, $-I_C = 1$ mA, $f = 100$ MHz | $f_T$ | 325 | MHz |
| Feedback capacitance<br>at $-V_{CE} = 10$ V, $-I_C = 1$ mA, $f = 1$ MHz | $-C_{re}$ | 0.35 | pF |
| Real part of output admittance<br>at $-V_{CE} = 10$ V, $-I_C = 1$ mA, $f = 0.5$ MHz | $g_{oe}$ | $< 8$ | µmho |
| Noise figure at $-V_{CE} = 10$ V,<br>$-I_C = 1$ mA, $f = 100$ kHz, $R_G = 300\ \Omega$ | $F$ | 2 | dB |

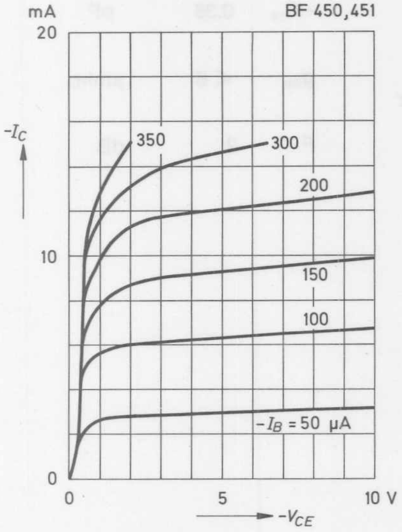
**Admissible power dissipation versus ambient temperature**
(see note on previous page)



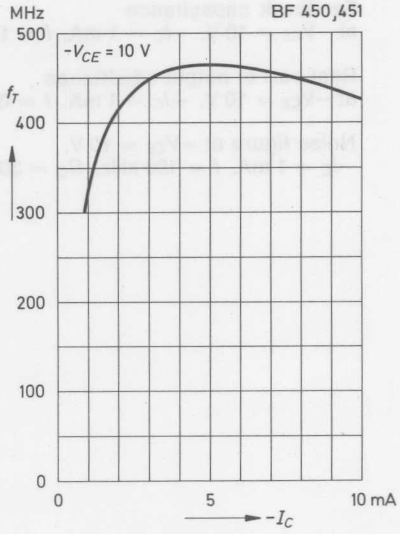

**Collector current versus base emitter voltage**



**Common emitter collector characteristics**



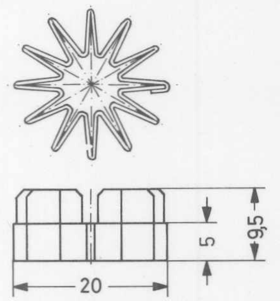

**Gain bandwidth product versus collector current**



## Accessories

**Heat sink KS 1 for TO-39 case**

fitting for all transistors in TO-39 case




Material: black varnished bronze beryllium
Weight approx. 2 g

Thermal resistance in free air:
$R_{thS} = 46\ °C/W$

Dimensions in mm

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General Information

NPN Silicon Transistors

NPN Silicon
High Frequency Transistors

PNP Silicon Transistors

PNP Silicon
High Frequency Transistors

Accessories